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SURGICAL ANATOMY.

BY

JOSEPH MACLISE,

FELLOW OF THE ROYAL COLLEGE OF SURGEONS.

Second Edition.

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I INSCRIBE THIS WORK

TO THE GENTLEMEN WITH WHOM AS A FELLOW-STUDENT I WAS ASSOCIATED

AT THE

LONDON UNIVERSITY COLLEGE:

AND IN AN ESPECIAL MANNER, IN THEIR NAME AS WELL AS MY OWN, I AVAIL MYSELF OF THE OPPORTUNITY TO RECORD,

ON THIS PAGE,

ALBEIT IN CHARACTERS LESS IMPRESSIVE THAN THOSE WHICH ARE WRITTEN

ON THE LIVING TABLET OF MEMORY,

THE DEBT OF GRATITUDE WHICH WE OWE

TO THE LATE

SAMUEL COOPER, F.R.S., AND ROBERT LISTON, F.R.S.,

TWO AMONG THE MANY DISTINGUISHED PROFESSORS OF THAT INSTITUTION,

WHOSE PUPILS WE HAVE BEEN,

AND FROM WHOM WE INHERIT THAT BETTER POSSESSION THAN LIFE ITSELF,

AN ASPIRATION FOR THE LIGHT OF SCIENCE.

JOSEPH MACLISE.

NOTICE TO THE SECOND EDITION.

Notwithstanding the favourable regards with which the First Edition of this Work appears to have been received, I myself have, since its publication, become too sensible of its many faults and deficiencies (which must, through kindliness, have been so lightly condemned) not to have used my best endeavours to revise and correct them, having been afforded an opportunity for doing so.

In the present Edition will be seen reproduced (by those who may choose to compare them) as much of the former one as has been considered worthy of notice, and also that large additions to the number of the Figures, and to the matter of the Commentaries on them, have been made. The original Plates have been all redrawn, and nearly all of them on a larger scale; they numbered thirty-five in the First Edition; they have had added to them seventeen new Plates, and altogether they amount at present to the number of fifty-two. The superadded Figures consist, for the most part, of those illustrative of the several forms of Aneurism as affecting all the principal arteries; some of them are additional illustrations of the varieties of Herniæ; others, of the mechanism of parts; others are demonstrations of subjects more or less interesting to surgical science, if not to surgical art; and others which are new anatomical views of regions and members in their normal conditions and relations.

With regard to the Commentaries, it will be observed that those which referred to the Plates contained in the First Edition have been all rewritten, recomposed, and considerably amplified, in such wise as to give to the dull details of mere descriptive anatomy a physiological as well as a surgical bearing; while those which refer to the additional Plates have been composed on a like plan and directed to the same purpose. With this prime object constantly in view, of rendering this Work complete as a *Surgical Anatomy*, it will appear, however, that occasionally I have indulged in such a consideration of the facts before me as may seem to many to have but a very remote tendency towards developing the requirements of a work with that title. For of what moment, it may be asked, can it be to the Operating Surgeon to know the signification of the intermaxillary bone in a case of hare-lip? of that of a cervical rib in a case of subclavian aneurism? of that of the cremaster muscle in herniotomy? of that of the prostate in lithotomy? of that of the mammary gland in excision of that organ? of that of the thyroid body in tracheotomy? of that of the spleen, or the liver, or any other part, while a Surgeon's argument is usually in his scalpel, and while his mode of solving a difficult subject is abscission? To those who would raise such an objection I have only to answer that I have at times left the beaten line of march but to seek recreation according to the following precept:—"Scientia et potentia humana in idem coincidunt, quia ignoratio causæ destituit effectum."—"Datæ autem naturæ formam, sive differentiam veram, sive naturam naturantem (ista enim vocabula habemus, quæ ad indicationem rei proxime accedunt) invenire, opus et intentio est humanæ scientiæ."—"Denique multum utilis est in quamplurimis sagacitas quædam in conquirendis et indagandis conformitatibus et similitudinibus physicis. Natura enim non nisi parendo vincitur: et quod in contemplatione instar causæ est, id in operatione instar regulæ est."—*Novum Organum.*

Led by this guiding light of the comparative method, I have, throughout the progress of these pages, recorded ideal and real facts even for the seemingly exhausted subject of Anthropotomy which have not hitherto been either written, spoken, or known; and which, in deference to the understanding of my philosophical professional readers, I would have hesitated to enunciate, did they not appear to me as the self-convincing countervails of the axiom that *Things which are equal to the same are equal to one another.*

J. M.

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PREFACE.

The object of this work is to present to the student of medicine and to the practitioner removed from the schools, a series of dissections demonstrating the anatomy of the principal regions of the human body. Whichever of the titles, surgical or medical, regional, relative, descriptive or topographical, may the most appropriately apply to a work of this kind, will matter little, provided its more salient or prominent character be manifested in its own form and feature. The work, as I have designed it, will itself show that my main intent has been to base the practical upon the anatomical, and to unite these wherever their mutual dependence was apparent. The surface of the living body is perused by the surgeon as a map explanatory of the relative position of the organs beneath; and to aid him in this respect, the present dissections have been made. We dissect the dead body in order to furnish the memory with as clear an account of the structures of its living representative, as if this latter, which we are not allowed to analyse, were perfectly translucent, and directly demonstrative of its component parts. Such is the subject-purpose of anatomy as applied to surgery and medicine. But considering Anatomy as a science, *per se*, the twin of Astronomy, and reaching towards a like imperial destiny, who that has a care for its advancement can suppress, at sight of this accumulation of facts, a longing to mount the pyramid, and with the telescope of imagination to look through Nature from the known to the unknown?

That department of anatomical research to which the name *descriptive* strictly applies, as confining itself to the dull, unreasoning account of the form and relative location of the several organs comprising the animal body, is almost wholly isolated from that spirit of inquiry which actuates and ennobles Physiology; and cannot therefore be expected to aim at those comprehensive views which anatomy, taken in its widest bearings as a science, necessarily includes. While the anatomist contents himself with merely numbering objects, as he exposes them layer after layer by his dissecting instruments, he does not, in truth, appear to rise any higher in the region of the intellectual than the level of the humblest mechanical art, which only recognises the existing arrangement of things relative to each other, and combinative for the particular design of the form of whatever species this may be, whether organic or inorganic—an animal or a machine. The descriptive anatomist of the human body aims at no higher walk in science than this; and hence his nomenclature lies as it is—a barbarous jargon, barren of all truthful signification, inconsonant with nature, and blindly irrespective of the *cognitio certa ex principiis certis exorta*. Shut up in his meagre subject, as in a *cul de sac* leading nowhere, and vegetating remote from the high road of intellectual collision, what deeper meaning can he (even were he Haller) be expected to see in the few objects of his experience, than that they are either *hyoid* or *xyphoid*, *styloid*, *coracoid*, *coccucoid*, or else *innominate*, when the little puddle of such invention has been used dry.

Still, however unsuitable this nomenclature of descriptive human anatomy proves to be, when used as an instrument for expounding the objects of purer science, we must own it need not disturb us, as medical or surgical practitioners, so far as our wants are concerned. By us the nomenclature, such as it is, is found to answer conveniently enough the special subject; the hand of man may be called a bootjack, so long as we mistake not the one object for the other. But when once we pass into the fields of comparison in quest of the higher generalizations, it is then we find how special names trammel our progress by their rude and shallow meaning.

The anatomy of the human body, when contemplated in comparison with that of other species of animals, imposes on the mind the task of inductive reasoning. The relationary properties of animal forms invite to comparison; this to induction; and upon this rests the science. But from human anatomy, as from a particular, we can never hope to infer one general proposition, however much we labour in the study of it; not though we weary ourselves in turning over whole hecatombs of this mortal quarry in our dissecting-rooms; for the form of any one species while existing alone, unrelated to its similars, can neither interpret itself, nor be the exponent of other forms, though a Hunter ply the scalpel. While restricted to the study of the isolated human form, the cramped judgment must waste in such narrow confine. It is only in the expansive gaze over all allying and allied species that the intellect, having scope for exercise, learns by comparison to overcome nature, to unveil her real character, and gain a sight of the majesty of naked truth in its entirety. When we have first experienced the analogies and differentials of the many, we are then fitted, on returning to the study of the one, to view this one of human type under manifold points of interest to which the eye of science was not previously awakened. And if by comparison of the many species we arrive at the true signification of the *human one*, why shall it not follow that even surgical anatomy may receive some benefit from the same process of analogical reasoning? For my own part, if I did not believe that it may, I would as soon undertake the repaving of a common thoroughfare, as the re-examination of the parts of the human body in the same spirit as, and with no other motive than, that of the ordinary dissector.

The surgical anatomist has for his object the attainment of an exact knowledge of the relative position of the several organs of the human body—their proper structures and their functions. To this end he is guided by the light of that same *comparative method* which (alone yielding the fruit of knowledge on whatever subject it is brought to bear) enables him in his own immediate subject to judge how the integral parts combine for the embodiment of the design as a whole in synthesis, and which, in turn, lends to those parts their only real signification in analysis. To the physician, to the surgeon, and to him who would combine both relationary practices of medicine and surgery, comparison serving alike, as that lens through which the judgment looks for the essential qualities of things, it follows that when one would pursue either mode of practice exclusive of the other, to do so with honest purpose and large range of understanding, he must be equally well versed in the subject-matter of both. It appears, in fact, more triflingly fashionable than seriously reasonable, to seek to define the line of demarcation between the special callings of medicine and surgery; for, the purpose being common to both, and the means (comparison) being the same, also, it will hence ever be as vain an endeavour to separate the one from the other, without extinguishing the vitality of both, as it would be to sunder the trunk from the head, and give to each a living individuality. The necessary division of labour is the only reason that can be advanced in excuse of specialisms, but it will be readily granted, that that practitioner who has first laid within himself the foundation of a general knowledge of matters relationary to his particular subject, will be best enabled to pursue this according to the dictates of science. The human body being *one* in which structure blends region with region, and unites all regions to form an indissoluble entirety, as well in function as in form, so rises up the majesty of our art—great, uniform, and *one*—an inductive science, set, like a Janus, with double aspect, watchful between causation and effect; the estate and world of suffering man her general hospital, and hers the ministering hand, the combatant antithesis of Disease, in whatever form that dread magician walks his empire wards.

Anatomy, therefore, while studied comparatively, and answering to the Γνῶθι σεαυτον, in respect to presential form, whether in health or disease, is the substratum or soil in which the tree of curative art must strike common root, however variously its trunk may branch into specialisms. With comparison as the nurse of reason, the parent tree must be cultivated, if we would make its special branches bear the real fruit of science. Contrast is our pioneer to truth. Of it alone spring our ideas of diversity and uniformity. It is a potent instrument—the only one in the hands of the pathologist, as well as in those of the physiologist—the philosophic generaliser of anatomical facts gathered from the extended survey of an animal kingdom. The human body in a state of health is the standard whereunto we compare that body in a state of disease. We can best recognise the condition of a dislocated joint when we have become well acquainted with its contour in the normal state. All abnormal conditions are best understood by contrasting them with those which we consider to be of normal character. Every anatomist is a comparer, in a greater or lesser degree, and he is the greatest anatomist who compares the most generally, for the knowledge of one thing can only exist for us by the knowledge of another thing, and by the comparison of both.

Impressed with this belief, I have been particular in imitating the normal form of the human body taken as a whole, in order the more clearly to express in one comparative view the relative position of its several regions, and of the various organs contained in each of these. Illustration by figures is a medium by which this subject of relative anatomy may be presented to the understanding in more vivid reality than it can be by any mode of written description. Indeed, the forms, of organic bodies especially, cannot be described in words without the aid of figures. Even the mathematical strength of Euclid would avail nothing if shorn of his diagrams. Form being the language in which Nature declares her presence, Science receives that presence, and alone imitates her by demonstrating her realities.

PREFACE.

An anatomical illustration enters the understanding at once in a direct passage, and is almost independent of the aid of language written or spoken. A picture of form is a proposition which solves itself. It is as an axiom encompassed in a framework of such self-evident truth, that the best substitute for Nature herself, by which we may teach the knowledge of her, is an exact representation of her form.

Every surgical anatomist will (if he examine himself) perceive that previously to undertaking the performance of an operation on the living body, he stands reassured and self-reliant in that degree in which he is capable of conjuring up before his mental vision a distinct picture of his subject. The mind being as a chart on which the senses chronicle our ideas, and memory being the persistence of those ideas, we are all but as reproducing draughtsmen of those ideas by whatever instrument we trace them in presential reality of form, whether by the scalpel of a Hunter, an Astley Cooper, or a Liston, or by the scalpel pen and pencil of a Charles Bell, a Camper, or a Scarpa, a Carus, or a Cuvier.

If there be any novelty now-a-days possible to be recognised on the out-trodden track of human relative anatomy, it can only be in truthful demonstrations well planned in aid of the requirements of surgical and medical practice. Under this view alone may the anatomist of the human body hope to add anything new to what we already know of that subject. Except the human anatomist turns now to the practical ends of his study, and marshals his little knowledge to bear upon those ends, one may proclaim anthropotomy to have worn itself out. Dissection can here do no more than to repeat a Meckel or a Cruveilhier; and that which these anatomists have done in demonstration of the parts of the human body, or that which a Cowper or a Sœmmering did before them, Müller would seem to have accomplished for its physiological interpretation; Burdach has philosophized upon it, and Magendie has experimented to the full upon this theme, in so far as it would permit. All have pushed the subject to its furthest limits in one point of view. The narrow circle is now foot-worn. All the sum of facts are long since gathered, sown, and known. We have been seekers after those facts from the days of Aristotle. And what is there now remaining to be done, if it be not to arrange the facts in hand, with a view to their proper interpretation? Are we to put off the day of attempting this interpretation for three thousand years more, in order to allow these dissectors time for knife-grinding, for hair-splitting, for sawing, chopping, and hammering this pauper *corpus mortuum* till the studious air of our cloisters rings like a shambles? How long are they to lead us on this dull road, weed-gathering, tracking out bloodvessels, tricking out nerves, and slicing the brain into still more delicate atoms than they have done hitherto, in order to coin more names, and swell the dictionary? Is this the work that waits its culminating point? No! as well may they count leaves in forests, pebbles on the sea shore. The work must now be retrospective, if we would render true knowledge progressive. It is not a list of new and disjointed facts that Science at present thirsts for, but she is impressed with the conviction that her wants can alone be supplied by the creation of a new and truthful theory—a generalization which the facts already known are sufficient to supply, if they were well ordered, according to their natural relationship and mutual dependence. "Le temps viendra peut-être," says Fontenelle, "que l'on joindra en un corps régulier ces membres épars; et, s'ils sont tels qu'on le souhaite, ils s'assembleront en quelque sorte d'eux-mêmes. Plusieurs vérités séparées, dès qu'elles sont en assez grand nombre, offrent si vivement à l'esprit leurs rapports et leur mutuelle dépendance, qu'il semble qu'après les avoir detachées par une espèce de violence les unes des autres, elles cherchent naturellement à se reunir." (Preface sur l'utilité des Sciences, &c.)

The comparison of facts already known should henceforward be as the scalpel which we are to take in hand. We have now but to return by the same road on which we set out, and re-examine the things and phenomena which, as novices, we have passed by too lightly. The travelled experience may now sit down and contemplate; for this endless search after new anatomical facts has already so exhausted the sinking soul of Science, that she heaves the gorge at thoughts of it. It must be now by the broad clarion sounds of laws and systems, not by the narrow piping notes of isolated particulars and dislocated phenomena, that we can ever hope to wake to attention again her slumbering ear. In what direction, well may it be asked, are we now to search for a new branch of nerve or artery, an unknown muscle, or process of bone? For what number of such facts are we still to rein-in impatience, and acknowledge our need of these, for the purpose of summing together the whole encircling and satisfying account of a law—of that law of *unity in variety*, the sum and substance of Nature's living volume, the true and final answer to our *quid est?*—whether we question the difference between two vertebræ, two hearts, or two brains, of any one species, or of all? The womb of anatomical science teems with the true interpretation of this law, but the birth (even though while of no greater bulk than a pamphlet, it would outweigh in worth all the dissectors' guide-books fossilized in the library strata of past time) is delayed, owing to the parent mind having become altogether "practical." Though Aristotle and Linnæus, Buffon, Cuvier, Geoffroy St. Hilaire, Leibnitz, Göthe, Hunter, and all such scions of the royal dynasty of mind, have lived and prescribed officially, yet the present state of knowledge proclaims that the unborn form of this transcendent law awaits some future Newton to help it into life. This is the subject for scalpels of the mind! The iron scalpel has already made acquaintance with not only the greater parts, but even with the infinitesimals of the human body, and Reason, confined to this narrow range of the subject, perceives herself to be imprisoned, and quenches her guiding light in despair. Originality has here outlived itself; discovery is here a fruitless enterprise; nor even though we pursue it in the microcosm on the field of the microscope, can we draw forth demonstrations of other objects than such as are, for aught I can see in them, as little in respect to "practical" importance as they are in regard to physical dimensions.

The subject of our study, whichever it happens to be, will appear exhausted of all interest and the promise of valuable novelty, owing to two reasons:—it may be, like descriptive human anatomy, so poor, so cold, and so sterile in its own nature, that it will be impossible for even the genius of Promethean fire to warm it; or else, as with existing physiology, the very instrument—the nomenclature of descriptive anatomy, through which we survey the theme, will blight the fair prospect of truth, distort induction, and shackle the arms of ratiocination. With the descriptive anatomist drawing analogies between things as unrelated to each other as are the contents of a swineherd's wallet to the twelve signs of heaven's zodiac! (for of what less vulgar origin come to us the names Pons, Fornix, Island, Tænia, Nates, Testes, Cornu, Hippocamp, Thalamus, Calamus, Vermes, Arbor Vitæ, Respiratory Tract, Ganglia of Increase, and all such phrases of unmeaning sound?) and with the physiologist adopting those names, and making no more question as to their import than as if he believed (which he cannot) that they bore the *imprimatur* of the Jupiter of Truth himself, what hope can Reason cherish of penetrating the cloud which envelopes the cerebro-spinal ens, and giving that casket of the mental jewels its proper signification? Custom alone sanctions our use of such names—this jogging custom, which shows the man but as the offspring of the child—but while

> "Custom calls us to it!
> What custom wills; should custom always do it,
> The dust on antique time will lie unswept,
> And mountainous error be too highly heaped
> For truth to overpeer."

But what, it may be asked by some, is the connexion between these remarks and the subject-matter which concerns surgery? The *surgeon* Hunter has printed the answer on the walls of his museum in types of flesh and bone—a votive tablet of greater note, and an offering more acceptable to Ζεὺς than Ammon's sword. Go there, you "practical men"—all you who ride with ever-trenchant operating steel, and you who run afoot in gabardines of Pharmacy, so loose and long, and yet can't stop a hiccup—go there, and read the bottled marvels, and learn how mind, the demigod, being as the sun "kissing carrion," can make that carrion teem; proclaiming of itself the true *resurgam* to deathless genius, whose mission it was, rather by patient thought to unravel this Gordian knot of life, than cut or physic it. Seeking, perhaps, like others, the profit-driving 'Change, a Hunter found, instead, the sacred Temple of Science, and entering that temple by mistake was so overruled by the solemnity of the place, and by the glory of the Tutelary Goddess within the inmost shrine, that he forgot his thrift. In him she saw a heartstruck votary; and as in confidence she opened out to him the folded volumes of her celestial robe, fretted with starry names, upon her breast she showed a vacant orbit where he might set *his* name as leading Hesperus! and this he did! yea! even while the warlock Jealousy arose, and, like a vampyre between him and his view, outspread its gloomy wing; made all that firmament its dark escutcheon; quartered the serpent rampant there; and trailed around that firmament, like to a bordering horizon, its hissing motto:—

> "Wo du das Genie erblickst
> Erblickst du auch Zugleich die Marterkrone."

Of the illustrations of this work I may state, in guarantee of their anatomical accuracy, that they have been made by myself, from my own dissections, first planned at the London University College, and afterwards realized at the Ecole Pratique and School of Anatomy, adjoining the Hôpital La Pitié, Paris, a few years since. Those representing pathological conditions of parts, I have made from *natural specimens*, recent and preserved, which I had the opportunity of examining at the Hospitals and Museums in Paris, London, and elsewhere.

J. M.

Fig 1.

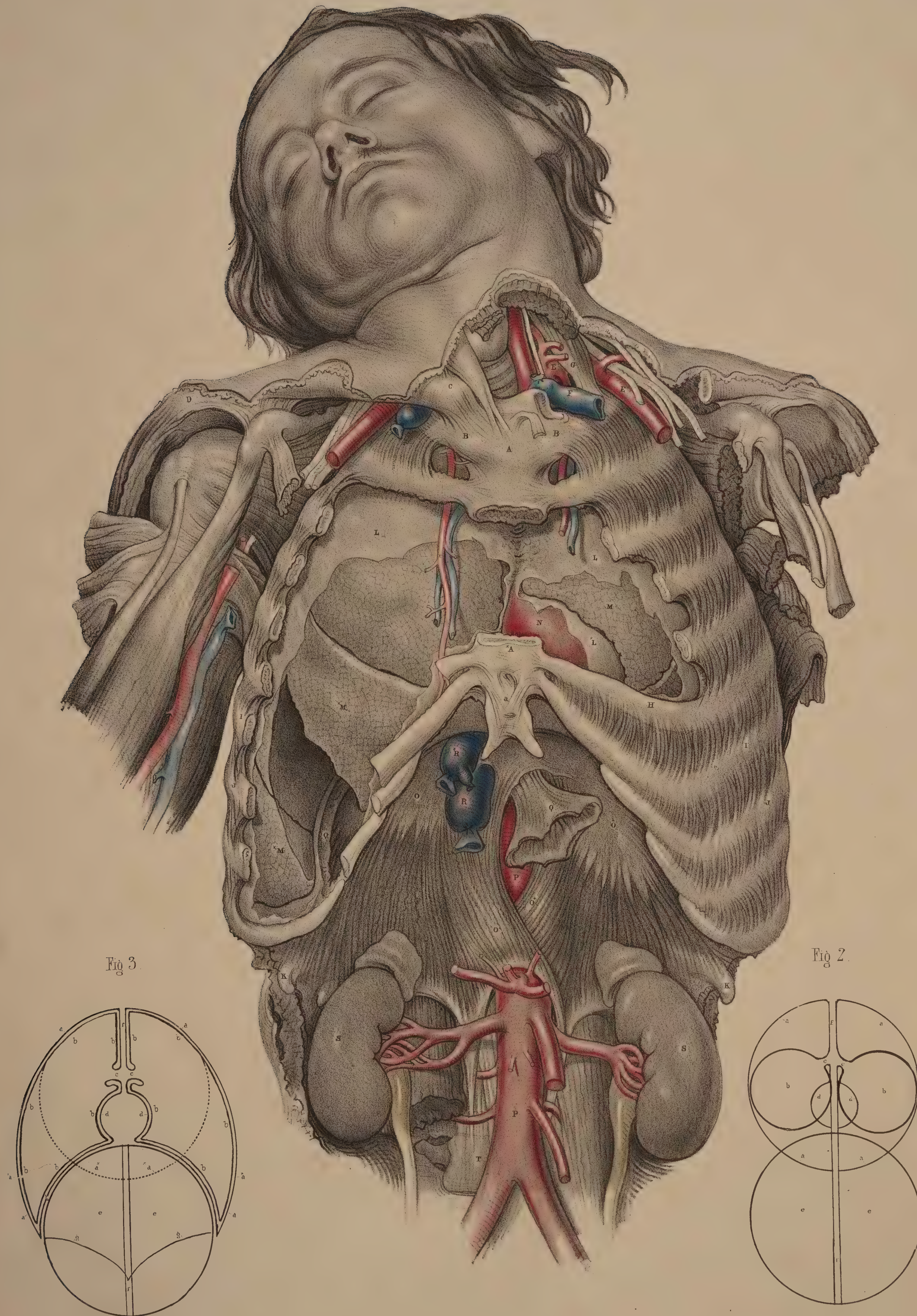


Fig 3

Fig 2.

M & N Hanhart, Imp.

COMMENTARY ON PLATES I. & II.

THE FORM OF THE THORAX, AND THE RELATIVE POSITION OF THE LUNGS, HEART, AND PRIMARY BLOODVESSELS, &c. THE MECHANISM OF THE RESPIRATORY APPARATUS.

In the human body, during life, there does not exist any such space as *cavity*, properly so called. Every space is fully occupied by its contents; and all hollow organs when not distended by passing matter are in a state of collapse. The thorax is completely filled by its proper viscera, which, in mass, take a perfect cast or model of its interior. The thoracic viscera lie so closely compacted that they in a great measure influence the form and dimensions of each other, as well in their active as in their passive state. That space which the lungs do not occupy is filled by the heart, great bloodvessels, œsophagus, nerves, &c. The position of the heart, N, Fig. 1, is central; that of the lungs, M M, is lateral. The thorax causes no vacuum in its interior by its motions of either inspiration or expiration; neither do the lungs nor the heart by dilatation or contraction. When either of these organs requires larger space, on account of its growth, or its functional expansion, it immediately inhabits such space at the expense of neighbouring parts. When the heart dilates, it encroaches on pulmonary space; and when the lung expands, general space diminishes in the same ratio.

The mechanism of respiration and circulation is cosmical as well as animal in principle; and consists in a constant oscillatory *nisus* to produce a vacuum, which, however, is never established. The animal or vital force of the thorax and heart opposes the cosmical force, and vainly strives to make exception to the irrevocable law, that "*nature abhors a vacuum.*" This opposition between both forces constitutes the respiratory act, and thus the thoracic apparatus (like a pendulum vibrating according to the action and counteraction of the force centrifugal and the force centripetal) inspires and expires in vibrative alternation, precisely indicative of the measure of its own action and atmospheric reaction. The inspiration of thoracic space is as it were the expiration of general space, and the reciprocal action of both constitutes respiratory motion. The anatomy of the thorax, while studied in elucidation of this principle, is replete with practical interest.

The thorax is that region of the body which the ribs, B H I J K, bound between the neck and abdomen. It contains the heart and lungs, and it is traversed by the main bloodvessels, the air-tube, the œsophagus, &c. The thorax, though giving passage to these parts, forms a compartment closed at all points, and upon its peculiar construction in this respect depends much of its efficiency as a pneumatical apparatus. Its shape is that of a symmetrical truncated cone, the apex of which is at the root of the neck, B B, the base being below, and forming at the same time the roof of the abdomen, O O. The walls of the thorax are formed partly of bone and muscle. The osseous parts consist superiorly of seven complete girdles, (formed respectively of a dorsal vertebra, a pair of opposite ribs, and a sternal piece,) arranged in slanting super-position; inferiorly they are formed of five girdles, which, not joining the sternum either as bone or cartilage, leave the osseous thorax incomplete across the epigastrium, O R Q O; but here the deficiency is supplied by such a disposition of the soft parts, as to render the respiratory chamber perfect as an inclosure. All the intercostal spaces, H I, are closed by muscles (intercostal), each of which is attached to the adjacent borders of a lateral pair of ribs. The intercostal muscles, whose action is principally subservient to respiration, consist severally of two layers of fibres internal and external, which, enclosed separately by laminæ of rather dense fibrous membrane, decussate each other, and are described as so disposed, in order to facilitate the approximation of the ribs at a less expense of muscular power than could with equal convenience be attained by any other arrangement. The motion in respect to each other between any two ribs is, however, but very limited at all times; but their collective motion is considerable, and of such a kind as to alter the area of the thoracic chamber, in almost all directions, from its stationary median plane. The intercostal muscles, though nearly equal in number to the ribs themselves, act nevertheless as one muscle in regard to time and the effect produced upon the capacity of the thorax. A separate intercostal muscle possesses no more isolated action than does a part of any other muscle of the body. The simultaneous contraction of the intercostals promotes the elevation and expansion of the thorax, while their relaxation is followed by its depression and partial collapse. Together they form that kind of series in bilateral symmetry, the individual members of which are so enlinked the one to the other, that one cannot act distinctly without exciting the whole number, not only on its own but on the opposite side. The first pair of opposite ribs, B B, being more fixed than any other pair in the series, and each pair in the order of descent becoming longer and more and more moveable, it follows that, under the influence of the intercostal muscles, not only must all the ribs tend to the position of the first pair, but that the lower and longer pairs affect the capacity of the thorax to a greater extent than the others. The spinal column being stationary, and having all the ribs articulated with it and acting on it, while the sternum, A A, is moveable with such of the ribs as are attached to it, so it must appear that the range of motion performed by each rib, and by the thorax as a whole, is greatest anteriorly and least posteriorly. Like the ribs and intercostal muscles themselves, the arteries, veins, and nerves, which course in relation to them, have a serial and symmetrical arrangement, thus indicating as well as serving the uniformity of function in which the thoracic apparatus performs.

The thorax is of much greater vertical extent behind than in front. The sternum, A A, measures the depth of the thorax anteriorly; the dorsal spine, posteriorly. The five asternal inferior ribs, A K, owing to their becoming gradually shorter from above downwards, cause this difference between the two vertical measurements. The summit of the thorax is bounded by the structures at the root of the neck, where the trachea, œsophagus, arteries, veins, and nerves, have their entrance and exit; the base is formed by the diaphragm, O O*, sloping backwards and downwards from the sternum, A, before, to the top of the lumbar spine behind, arching transversely from the borders of the false ribs, A K, of one side to those of the other, and presenting along the middle line *three* principal openings; *one* of which is in the right half of its *cordiform tendon*, for the passage of the *inferior vena cava*, which vessel is thereby *secured against constriction* when the muscle is in action; *another*, situated more posteriorly in its *muscular part*, through which the *œsophagus* passes, and which may therefore be believed to serve the *office of closing that tube;* and *another*, situated between the *tendinous pillars* of the muscle, *permanently patent*, for the passage of the *aorta*, *thoracic duct*, *and several important nerves*. The diaphragm forms at the same time a moveable convex floor for the thorax, and a concave roof for the abdomen; from which circumstance it will be inferred how the action of this muscle must affect the capacities of both these compartments at one and the same time. The transverse and antero-posterior diameters of the thorax increase gradually from its summit to its base. Its transverse is greater than its antero-posterior diameters at all levels.

The external form of the thorax, Plate II., is somewhat obscured by the

FIGURES OF PLATE I.

Figure I.

A A*. The sternum; *a*. the xiphoid cartilage. — B B. Sternal ends of the first ribs. — C. Sternal end of the right clavicle. — D. Acromion process. — E E. Left subclavian artery. — *e*. Internal Mammary artery, and vein. — F. Subclavian vein. — G. Anterior scalenus muscle. — H. Cartilage of the sixth rib. — I. Seventh rib. — J. Eighth rib. — K. Eleventh rib. — L L. Right and left costal pleuræ. — L*. Pericardial pleura. — M M*. Right and left lung. — M* M*. Section of middle lobe of right lung. — N. Pericardium. — O. Diaphragm. O O*. Its crura. — P. Thoracic aorta seen through œsophageal opening of diaphragm. — P*. Abdominal aorta. — Q. Cardiac end of stomach. — R. Inferior vena cava, cut. — R*. Trunk of hepatic vein. — S. Right and left kidneys. — T. Fourth lumbar vertebra.

Figures II. & III.

Plans showing the relative position of the thorax, lined by the pleura, and of the abdomen, lined by the peritoneum. *a a a a*. Parietal pleuræ. — *b b*. Pulmonary pleuræ, collapsed, and expanded. — *c c*. Roots of the lungs invested by the pleuræ, and maintaining the continuity of the parietal and pulmonary parts of those membranes. — *d d*. Pleura investing the pericardium as it does the lungs. — *e e*. Peritoneum lining the walls of the abdomen, and forming an arch intersecting that of the thorax. — *f f*. The thoracic median line, indicated by the mediastinal sides of both pleural sacs.

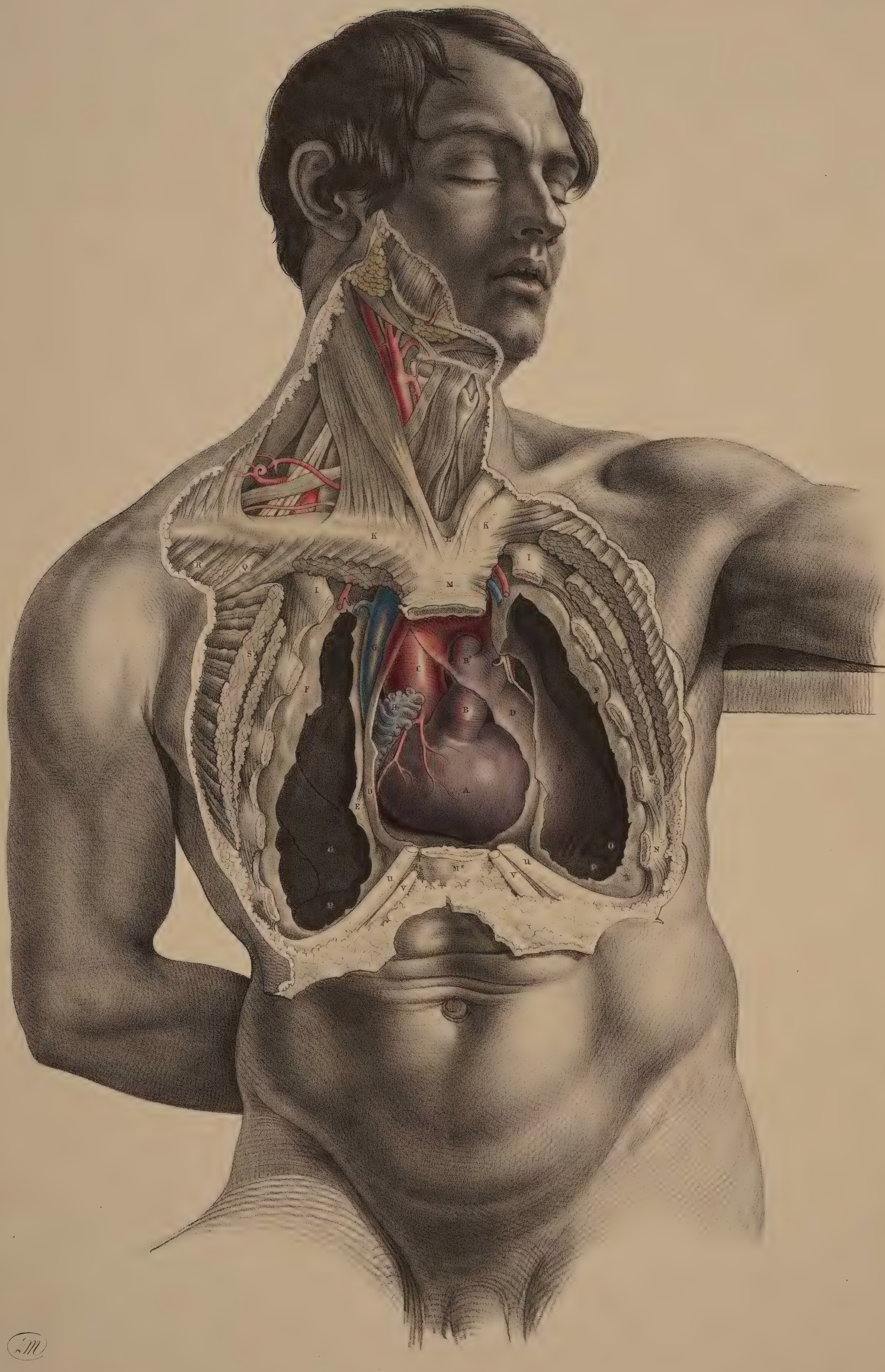
soft parts which cover it. In regard to the absolute dimensions of its upper part, we are particularly liable to err in consequence of its being here surrounded by the osseous and muscular structures which compose the shoulder apparatus. The width of the thorax, I I, between the shoulders, is equal in transverse diameter to only about the inner thirds of the clavicles, K K, and first sternal piece, L, inclusive; its middle and lower circumferences, N N, are more readily definable beneath the surface, while its walls at the sub-axillary regions are comparatively superficial. Anteriorly, the upper and lateral two-thirds of the thorax are covered by the greater and lesser pectoral muscles, S T, of either side, arising from the sternum and adjacent parts of the ribs, and being directed outwards to their insertions, the great pectoral into the neck of the humerus, and the lesser pectoral into the coracoid process of the scapula. At the cellular interval, Q, below the clavicle and between the great pectoral, S, and deltoid muscle, R, the two pectoral part from contact with the walls of the thorax. Laterally, between the axillary borders of the pectoral and latissimus dorsi muscles, the thoracic walls are closely invested by the serrati magni muscles above, and the external oblique muscles of the abdomen below, both muscles interdigitating by their costal attachments at a line marking, from above downwards, the middle of this region. Posteriorly, the dorsal muscles, in layers, form a mass in close contact with the ribs on either side of the spine, from the prominent spinous process of the seventh cervical vertebra to that of the last dorsal, which two points mark the extent of the thorax at this aspect; while on either side, the scapulæ, covered by their proper muscles, shield the thoracic walls. The scapulæ, and the muscles more immediately connected with them, obey, however, the motions of the upper limbs so freely, that by folding the latter in front of the body, the scapulæ may be withdrawn to a considerable distance from the spine, and the thorax here rendered more superficial for whatever purpose required. The above-mentioned observations, however requisite it becomes to remember them in examining the well-conditioned adult body, will be found of less moment in regard to emaciated subjects, in whom the osseous thorax reveals its shape almost completely, the ribs being subcutaneous in nearly all situations.

The thorax is divided vertically through the median line into two lateral chambers, O O, Plate II., which respectively contain the right and left lung, M M, Plate I. The sternum in front, and the dorsal spine behind, coincide with the median line. The bodies of the vertebræ project forwards, while the ribs arching backwards and outwards from them, form the lateral deep thoracic grooves, in which the thick back parts of the lungs are received. Each pulmonary chamber is lined by a serous membrane, L L, Plate I., F E, Plate II. (the pleura), which forms a shut sac. The two pleuræ, *a b*, Figure 3, Plate I., are absolutely distinct sacs. Their outer anterior and posterior sides line the thoracic walls; their bases cover the diaphragm; their summits project into the neck somewhat above the level of the first ribs, coming into contact with the subclavian arteries, E, Figure 1, Plate I., inside the scaleni muscles; and by their inner sides they form the mediastinum, *f*, Figure 3, Plate I., E E, Plate II., that vertical membranous partition which extends from the root of the neck to the diaphragm, and from the sternum to the dorsal spine. All the thoracic organs, not excepting the lungs themselves, are situated between the mediastinal sides of the two pleural sacs, as shown in Figures 2 and 3, Plate I. The heart and lungs, by separating the mediastinal layers to a distance corresponding with the respective dimensions of those organs, become invested by the membranes, and thus each pleural sac remains still perfectly closed at all points. That portion of the pleura which forms an immediate covering for the lung, is therefore as truly mediastinal as that which covers the heart, the difference between the two parts being due solely to the circumstance that the pulmonary membrane is carried to a greater distance from the median line than the cardiac membrane.

A just idea of the forms of both pleuræ, and the manner in which they invest the thoracic organs and line the thorax, may be gained by a reference to the history of development, Figures 2, 3, Plate I.:—Two simple sacs at first appear side by side at the thoracic median line, *f*, and the adjacent sides being flattened against each other form the mediastinum. Between the sides in contact are next deposited the cardiac, *d d*, and the pulmonary germs, *b b*, and these in process of growth bulge those sides apart from each other, and from the median line, to an extent, the heart equal to its own bulk, *d d*, but the lungs to such a degree that the mediastinal, now become the pulmonary pleura, *b b*, Figure 3, is borne into general apposition with those sides, *a a*, of the sacs (pleuræ costales), which line the thoracic walls. In this way the pleural sacs are deprived of included space, and during life in the healthy condition, the parts, merely moistened by a serous exudation, exist in a state of absolute collapse, which is equal to absolute vacuum. This state is necessary to the perfection of respiratory motion. The full expansion of the lungs implies the complete collapse of the sacs, *a b*, Figure 3; and the interior of those membranes being thus represented by sides in contact, it therefore follows that all the thoracic space is actually mediastinal or interpleural.

The thoracic organs, when examined from before, backwards, between the two pleuræ, appear in the following order:—Behind the sternum, A A, Figure 1, Plate I., the triangulares-sterni muscle and the remains of the thymus gland, with some cellular membrane, separate the pleural sacs at a small interval, named *anterior mediastinum*, the upper end of which communicates with the neck; the lower end with the sheath of the rectus abdominis muscle, owing to a deficiency in the diaphragm behind the xiphoid cartilage. Next, the heart and primary bloodvessels, A B C G, Plate II., separate them at a space, E E, known as *middle* (cardiac) *mediastinum*, through which, on either side of the heart, the phrenic and branches of the vagus nerves descend. Behind this space the pleuræ meeting become again separated so as to invest the pulmonary vessels and lungs, forming what I may call the *pulmonary mediastinum*, *b c*, *b c*, Figure 3, Plate I., which in fact equals two-thirds of the area of the thorax. Behind the roots of the lungs the sacs meet and again separate in front of the dorsal vertebræ, so as to form the *posterior mediastinum*, which is traversed by the trachea, œsophagus, descending aorta, thoracic duct, and lymphatic vessels, vena azygos; vagus and sympathetic nerves; and from this situation the intercostal vessels and nerves pass outwards, coursing between each pair of ribs, and externally to the parietal part of the pleural sac, L, Figure 1, Plate I. From this disposition of the pleural sacs it will be seen, that all the contents of the thorax, though invested by those membranes, are excluded from their proper interior; and the same remark strictly applies to all other serous membranes, the arachnoid within the cranium, the peritoneum within the abdomen, the tunica vaginalis within the scrotum, the serous lining of the pericardium, and the synovial membranes lining the joints. In this may be observed an illustration of the general rule, that Nature repeats her first design, for having so perfected the original she needs but to add the slightest shades of modification in order to adapt it to various requirements.

The two lungs, M M, Figure 1, Plate I., are of unequal size. The left is less than the right by so much space as the heart, N, occupies of the left pulmonary compartment, more than of the right. The right lung is usually divided into three lobes; the left into two. The base of the heart, A B, Plate II., and the roots of the great bloodvessels enveloped by the pericardium, D D, are seated behind the sternum, M M, but separated a little from this bone by the thin anterior edges of the lungs. Behind and on the left side of the lower third of the sternum, the left lung generally reveals the pericardium, N, Figure 1, Plate I., to some extent; the pleura is also here deficient. The right auricle, H, Plate II., is placed behind the third intercostal space, close to the right side of the sternum, while the apex of the left ventricle protruding beyond the right, reaches to near the fifth intercostal space, N V, of the left side, midway between the mamilla and the margin of the false ribs. Between the situation of the right auricle and that to which the apex of the heart points, the whole extent of the right ventricle is presented to the surface, the edges of the lungs intervening. The heart, especially in the erect posture of the body, sinks to a level somewhat below the sternal cartilages of the seventh ribs; and at this situation (scrobiculus cordis, *a*, Figure 1, Plate I.) the motion of the right ventricle will be found to agitate the surface in the living person, in whom disease or original malformation does not exist. At this place the tendinous centre of the diaphragm yields somewhat with the weight of the heart towards the abdomen. The ascending part of the aortic arch, C, Plate II., is placed behind the middle third of the sternum, lying so close to this bone, that the vessel becomes flattened against it on injecting the heart from the abdominal aorta. The heart, A, Plate II., resting upon the diaphragm, P P, in the relative position now marked out, is bound to the tendinous middle of this muscle by the fibrous pericardium, D D; and though it rises and sinks according to the motions of the muscle in respiration, it is prevented from swaying much to either side, whatever be the position of the body, thus offering no impediment to pulmonary expansion. Regarding the form of the thorax in relation to the abdomen, Plate I., Figure 1, and at the same time the amount of space occupied by the heart, N, in both pulmonary chambers, we gain a true estimate of the varying thickness of pulmonary tissue through all diameters of the thorax. Of these diameters the greatest are the antero-posterior and transverse on the right side; the least being where the lungs are thinnest in front of



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the heart, over the hypochondria, A M K, and low down in the dorsal region, between the ribs and diaphragm, O O. The heart tends sternad and to the left side; the lungs tend dorsad, and to either side. In these situations, the sounds (normal and abnormal) of the heart and lungs may be heard with a greater degree of clearness than elsewhere.

The thorax, composed partly of bone, of cartilage, and of muscular tissue, is thereby calculated for fixity, elasticity, and mobility; three conditions necessary for the perfection of respiratory motion. The osseous ribs render it resistant; and being separated at regular intervals from each other, inclined at varying angles with the spinal column, articulated by their posterior ends with that part, and having their anterior ends joined by cartilage to the moveable sternum, they allow of the degree of mobility required. The costal cartilages render the thorax elastic, and by this property of elasticity the whole machine, when under the influence of muscular force, tends to resume its original quiescent state. The intercostal muscles regulate the motions of the ribs, and with the other respiratory muscles are the active opponents of the passive elastic force of the cartilages. To prove the existence of design in the arrangement of these elemental parts would be a task of supererogation; but to appreciate it fully is a duty, and to this end we have only in fancy to transpose these elements from their natural relative position, or to suppose the thoracic walls composed wholly of bone, of cartilage, or of muscle, and then contrast fitness with unfitness.

The thorax varies in form and capacity according to the respiratory motions, and chiefly so at its base. Its summit is scarcely at all affected in ordinary, and but little even in forced respiration. The upper ribs are not only less moveable, but much shorter than the lower ribs. All the ribs slant downwards and forwards, describing angles of varying degrees in respect to the spinal column. The lower ribs are much more oblique than the upper ones. Upon this difference as to length, mobility, and obliquity, between the ribs above and below, it can be demonstrated geometrically, that while all of them are being elevated and depressed during alternating inspiration and expiration, the greater range of motion is performed by the lower ribs, and the capacity of the thorax is chiefly altered by and opposite to these. In forced inspiration and expiration, the capacity of the thorax is by turns increased and lessened in all diameters, but more particularly so in the vertical. In ordinary inspiration, its capacity is almost solely altered in the vertical diameter, and this is effected by the tensive action of the diaphragm, which causes the abdominal viscera to recede in the same degree as the lungs dilate.

The thorax, *per se*, is not the originator of respiratory motion. Many circumstances combine for the efficient performance of this function; and the part which the thorax, or any other structure, contributes, would be void, unless all of them concurred in the act. The thorax is shaped in reference to the abdomen, and the latter becomes as much a principal in respiratory motion as the former. The organs contained in both compartments, and the manner in which those organs are contained, are as necessary to the act as the system of muscles which surround the parts, or the free access of air to the lungs.

The respiratory system of muscles is divided by anatomists into two classes—those of inspiration, and those of expiration. Under the former head are arranged, the sterno-mastoid, scaleni, sterno-hyoid and thyroid, the subclavian, pectoralis major and minor, serratus magnus and serratus posticus superior, the diaphragm and the intercostal muscles. As expiratory muscles are named, those of the abdomen, the latissimus dorsi, the triangulares sterni, the serratus posticus inferior, the quadratus lumborum, and other muscles of the back, the diaphragm, and the levator ani. According as the parts from which many of these muscles arise, or into which they are inserted, become fixed points, these muscles act either as expiratory or inspiratory; and hence the difficulty of forming a correct distinction among them according to their special functions. Considering them, however, according to the classification given, it becomes evident that the inspiratory muscles are much more remarkable for number, size, and power, than the expiratory; and, indeed, if it were said that the latter exist more in imagination than in reality, a good proof of the correctness of that opinion may be had in the fact, that the relaxation of the muscles of respiration in general, by allowing the natural recoil of the thoracic walls and of the lungs themselves to occur unimpeded, is all-sufficient for expiration as ordinarily performed. The diaphragm, intercostal and abdominal muscles are the sole agents in ordinary respiration; the action of these muscles is reciprocal-compensative; and the thorax and abdomen themselves are correlative, and so mutually obedient in all their parts for the due performance of the process, that when we would describe the respiratory apparatus, it is necessary to consider the two chambers as halves of the one whole machine. The diaphragm is passive in expiration, active in inspiration. While the diaphragm is relaxed it presents an arched form, having followed the recoiling lungs upwards; but during its active state, in inspiration, it is straitened transversely between the margins of the false ribs, and to this level the heart and lungs descend, while at the same time the ventral muscles give way, so as to allow space for the ventral organs, the lungs having encroached upon their situation. In forced expiration, the abdominal muscles are the principal agents; but their power in contracting the pulmonary chamber is exerted indirectly through the medium of the abdominal viscera, which, under compression, impel the flaccid diaphragm upwards. The parts, whether principal or otherwise, performed by each member of the respiratory system of muscles, are best defined by such injuries as involve the nerves which supply them; and of these kinds of injuries it is only necessary to mention a few, in order to show by what agents the respiratory motion is chiefly performed.

In cases where the cervical spinal cord has suffered injury above the origin of the phrenic nerves the whole system of respiratory muscles innervated from sources below such injury becomes paralysed, and respiration ceases, thus preventing our distinguishing the more important respiratory muscles from the less so. When the seat of injury is at the junction of the cervical and dorsal spine below the origin of the phrenic nerves, but above those nerves which are distributed to the thoracic and abdominal muscles, ordinary respiration is nevertheless performed by the diaphragm and the elasticity of the thorax independent of those muscles, but forced respiration is prevented. When the injury has occurred at the lower part of the dorsal spine, below the thoracic nerves but above the abdominal nerves, we find ordinary respiration to continue unimpeded, and at the same time forced inspiration may now be performed, though forced expiration is hindered. Lastly, if the cord be injured at the junction of the lumbar and sacral spine, below the thoracic and the abdominal nerves, all the movements of respiration, ordinary and forced, are capable of being performed. From these facts, which, in illustration of this point, I offer from my own observation, I believe it may be very plainly inferred upon what agents the respiratory motions depend in chief, and which are the mere accessories.

On viewing the manner in which the muscles are arranged around the thorax, it must be evident that the power which they are capable of exerting in expanding this apparatus in the act of inspiration is but very trifling, notwithstanding their number and size. The fact is, that their principal force is otherwise expended; and their action in imparting motion to the thoracic walls is but secondary. The traction of the muscles upon the ribs is made at very disadvantageous angles, so much so, indeed, that in most instances the agents and parts acted upon lie parallel with each other. A greater force, however, than that which they exert for the respiratory movements would be superfluous. The atmospheric pressure upon the pulmonary mucous lining membrane within the thorax, and externally upon the cutaneous surface, is, while the glottis remains open, in exact equilibrium; and to disturb this equilibrium requires no greater amount of power than is necessary to cause one arm of a balance in equipoise to preponderate over the other. The free access of air to the lungs is requisite to the free action of the respiratory muscles, for so low is their power in expanding the thorax, that we find them as useless, in this particular action, when the glottis is closed, as if they were actually paralysed. Such being the state of the muscular apparatus as agents in the respiratory process, we find, on examining the pulmonary organs themselves, a simple and beautiful disposition of them, which mainly promotes the easeful performance of that process.

The lungs, not having (as I believe) muscular fibre as a component of their tissue, must therefore be wholly passive in the respiratory act. They are elastic but not contractile, and would remain in their position altogether inert—unmoved by any effort even of the respiratory muscles,

FIGURES OF PLATE II.

A. The right ventricle of the heart. — B. Origin of the pulmonary artery. — C. Origin of the aorta. — D D. The pericardium. — E E. Mediastinal pleura. — F F. Costal pleura. — G. Superior vena cava. — H. Right auricle. — I I. First pair of ribs, cut. — K K. Clavicles. — L. Top of the sternum. — M M. The sternum, its middle part removed. — N N. Fifth pair of ribs, cut. — O O. Collapsed lungs. — P P. The diaphragm. — Q. Pectoro-deltoid interval. — R. Deltoid muscle — S S. Great pectoral musles, cut. — T T. Lesser pectoral muscles, cut. —U. Cartilages of the sixth ribs. — V. Cartilages of the seventh ribs.

but for the circumstance of the pleura which invests them being a shut sac closed on all sides, and collapsed at all points. What the fulcrum or point of suspension is to a balance, the touching surfaces of the collapsed pleural sac is to the thoracic machine. If the fulcrum be disturbed from the due line of gravity, or the pleural surfaces sundered from contact, the derangement of either machine is the result. The action of the respiratory muscles tends to withdraw the parietal from the pulmonary pleura, and so to create space *in vacuo*, but on the effort the external air enters the lungs by the glottis, and expands those organs in such measure as to maintain the pleural collapse complete. Now, while this general contact between the pleura costalis and pulmonalis is not less perfect than if the lung and thoracic wall were structurally united, it is obvious that in their structural distinctness some necessary purpose must be served which mere union of the surfaces could not supply. This purpose is to allow of a sliding motion between the lung and thoracic parietes, by which the pulmonary tissue may be the more perfectly expanded; the lung adapting itself to the increase of space occasioned by the dilatation of the thorax in inspiration. In furtherance of this end, too, the lungs are divided into lobes, which slide on each other; and the degree of this motion is indicated in the length of those organized bands by which the pulmonary and costal pleuræ are occasionally found adherent.

The complete collapse of the pleura is a condition, the nucleus, as it were, of the principle upon which the respiratory apparatus is planned, and according to which, all members of that apparatus subserve. The *interior* of the pleura in the healthy living thorax may be said to represent *nihil*. It is a state of less presential property than vacuum, for *vacuum is space void, while absolute collapse is void spaceless.* Upon this state a motor power—a cause—operates, and in the effort to disturb it disturbs the atmosphere on either side of it, of which disturbance the expansion of the lung is the result, of which result the chemical change of the blood again results, and hence onwards through all the links of the circling chain of causation, illustrating (as closely as any phenomenon in nature can be said to do it) the genesis of matter—the *ab nihilo ens gignitur*.

The shape, mobility, and relative proportions of the thorax vary at different periods of life. In very early life its antero-posterior exceeds its transverse diameter, owing to the lungs being small, and the heart and thymus gland being relatively large. During this early period, also, we find the vertical diameter to be comparatively short, in consequence of the small size of the lungs, and the largely developed state of the abdominal organs, more particularly the liver, which occupies nearly the whole width of the abdomen under the diaphragm. In the healthy, well-formed adult male, the size of the thorax, compared with the abdomen, is large, and corresponds with the voluminous lungs; the respiratory muscles, too, are now fully developed, and the whole thoracic apparatus presents an unequivocal sign of physical vigour, compared with which, as a standard, many pathological conditions may be detected. In extreme old age, the thorax presents certain characters which may be regarded as strand-marks, indicative of the degree in which the vital tide has ebbed; the costal cartilages have become ossified, and the different pieces anchylosed, so that the elasticity and mobility of the thorax fail, *pari passu*, with the structural and functional decline of the lungs themselves. In such a condition of parts, respiration is carried on solely by the diaphragm and abdominal muscles.

Besides the pathological and congenital deformities of the thorax, there are others which are the effects of art—the continued pressure of the corset, for example, causes the long flexible asternal cartilages to yield and dislocate permanently upwards, the liver, spleen, and stomach, so that the thoracic space becomes contracted, the action of the diaphragm impeded, and the summits of the lungs are in consequence protruded considerably above the level of the first ribs. The lung being thus forced into contact with the subclavian and other large vessels here situated, it seems to me probable that the *bruit* or murmur heard through the stethoscope applied to this situation in pallid emaciated females is symptomatic only of this unnatural state of the parts, and is due either to the pulsatile action of those vessels against the top of the lung; or to the obstruction of the circulation caused by the pressure of the instrument itself on turgid veins; or to the pressure of these vessels against some enlarged lymphatic bodies; or to the confluence of two main currents through the internal jugular and subclavian veins at their point of junction in the innominate vein so close to the right auricle and ventricle, which latter, at every contraction, are known to send the blood retrograde to a certain extent through those vessels. At all events it would appear more reasonable to attribute the murmur to either one or the other of these anatomical circumstances, than to account for it by supposing some peculiar state of the blood in the affection called *chlorosis*. The thorax of the adult female is naturally much wider in the base than that of the adult male, and altogether exhibits more of the infantile proportions. The female form in general presents an intermediate stage of development between that of the child and the man, insomuch that the prominent character of the female body is *abdominal*, whereas that of the male body is *thoracic*, the physical conformation of the latter adapting him to manual labour, and that of the former suiting her to labour of another kind—parturition, for the easy performance of which, the unnatural, cramped-in bodiced bondage, is so ill calculated.* While the beautiful is the fitting, and both features combine in the natural always, what more unseemly contrast to this state can the artificial exhibit than the physiological condition of the contracted waist of the European woman, unless it be the compressed forehead of the Carib, or the crushed foot of the Chinese.

The form of the thorax, and the relative position of its organs in their healthy state, require to be accurately determined, in order to give precision to the practice of auscultation and percussion, as a means of diagnosing cases of thoracic disease. In health the lungs expand into contact with all the *costal* parts of the thoracic walls. On these parts being struck, the lung emits a sound characteristic of its structure; and its respiratory murmur is also discernible by the ear. But the pulmonary resonance cannot be expected to be uniform over all the costal region, for it must vary, because of the variable thickness of the structures which lie upon the thorax, and also of the lungs themselves, between which the large compact mass of the heart is placed. Over the region of the heart and that of the liver, which ascends behind the lower ribs of the right side, the thin edges of the lungs which overlap those organs must yield a sound of a very different (shallow) character to that emitted (deep) at the sub-axillary and dorsal regions, where the lungs are thick. Naturally, the right lung is shorter in its vertical diameter than the left, but yet the volume of both appears nearly equal, owing to the fact that the heart inclining to the left side diminishes the transverse diameter of the left lung in a degree equal to what it exceeds the right in its vertical diameter. The shortness of the right lung is due to the circumstance that the liver protrudes the diaphragm into the right pulmonary chamber, considerably above the level of the margins of the false ribs at that side. The narrowness of the left lung is owing to the presence of the heart on the left side. These facts in regard to the healthy sounds demand therefore due consideration while conducting our pathological investigations, since, for example, when an atrophy of the liver or a hypertrophy of the spleen, a dropsy of the thorax or of the abdomen, modifies those signs which are indicative of the natural healthy condition of the parts, we cannot, without an acquaintance with this condition as a standard of comparison, detect the exact difference resulting from disease.

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* That the thoracico-abdominal muscles are the principal, if, indeed, not the sole agents, in parturient motion, can scarcely, I think, be reasonably doubted by any of us. Upon this point I have long since satisfied myself, having taken opportunities of noting the naked body of Nature in travail, not only in her private and her hospital bed, but in her open fields, *sub cœlo*. In that process, the uterus (notwithstanding all that the obstetricians would have us credit as to its paramount power in the expulsion of the fœtus) is little more active than the stomach is in the effort of vomiting, or than the bladder in voiding its contents. As to the questions, whether the gravid uterus be muscular or not, or whether those cords be or be not nerves, which have been described as traversing the substance of the uterus in that state, such questions may remain undetermined so long as anatomy demonstrates that the organ is not supplied with nerves from the cerebro-spinal axis, is not, therefore, under the same nervous influence as the voluntary system of muscles, and so long as with our eyes we see those muscles in violent contraction during the "bearing-down" efforts. The very necessity, indeed, for the *Physiological* researches of *Madame* Boivin herself (whose *spontaneous* opinion as to the agency, degree, and kind of parturient motion, might be supposed all-sufficient), may be regarded as good proof that the uterus is but little active in all its states; that, *per se*, it has not only no *voluntary* but very insignificant *involuntary* motion during labour. That the organ possesses muscular fibres and nerves we did not require to be informed by the personal dissections of that *lady-savant*, any more than we needed to know of the existence of the nerves and muscular fibres of the stomach and urinary bladder, but that those fibres in either organ are capable for any other purpose than that of maintaining its form and giving it tonicity may, I think, be distrusted. It must, therefore, appear, that it is upon the agency of the thoracico-abdominal muscles the gravid uterus depends for the expulsion of its contents. And that this is the truth I am so convinced as to believe that if, during parturition, any accident could arise, which, without involving other functions, would cut off nervous influence from those muscles, the uterus, though not affected by that accident, would be found, if not absolutely inert, yet incapable of itself to complete the process—incapable of itself to make the "bearing-down" efforts. The natural form of the abdominal chamber and the unembarrassed action of the surrounding muscles being, therefore, so essential to the easeful process of parturition, we can guess the state of those parts after having been subjected to a life of habitual distortion; we can understand why Girdled Fashion (aborting in her boudoir) shrieks for her immaculate accoucheur, while Gipsy Freedom (parturient in her ditch) makes no more ado about the matter than a cow calving.

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COMMENTARY ON PLATES III. & IV.

THE SURGICAL DISSECTION OF THE THORAX AND THE EPISTERNAL REGION. DELIGATION OF THE PRIMARY AORTIC BRANCHES. PENETRATING WOUNDS. PARACENTESIS. TRACHEOTOMY. LARYNGOTOMY.

The human body is developed in strict accordance with the law of symmetry. All forms throughout the animal kingdom exhibit the operation of this law. The general median line of the human body marks the junction of its two equal and similar sides. The features visible on the cutaneous surface at, and on either side of this line, owe their symmetry to the subjacent structures on which they are founded. The vascular as well as the osseous skeleton displays symmetry; but while the latter offers no exception to this kind of conformation, the vascular skeleton presents a few, and these, it will be observed, occur at the median line, which, being the seat of metamorphosis, may therefore account for their appearance. In a surgical point of view, this law arrests our attention; for, as all lateral parts have their counterparts, the various operations requiring to be performed in respect to one side, have to be conducted in a similar manner on the other.

When the integuments, cellular membrane, and superficial fascia are removed from the fore parts of the neck and thorax, we find the two sterno-mastoid muscles, A A, Figures 2, 3, Plate IV., converging from the sides of the neck towards the first bone of the sternum, W, into the upper and fore part of which they are inserted. From this situation, downwards, the sternum may be seen occupying the mesial line in the front of the thorax, and giving origin to the two great pectoral muscles, which, arising also from the inner halves of the clavicles, appear stretched over the sides of the thorax. Immediately above the sternum, and between the sternal parts of the sterno-mastoid muscles, will be observed a depression, *b* W, about half an inch in depth, and corresponding with the thickness of the bone. At the bottom of this depression (episternal pit), the sterno-hyoid and thyroid muscles, H J, will be found to arise from the back part of the upper end of the sternum, and to ascend to their insertions into the hyoid bone and the thyroid cartilage. Between the two sterno-hyoid muscles, which nearly touch by their inner borders, a cellular interval will be seen, marking the mesial line of the neck. All the muscles now under notice are invested by the cervical fascia, B *b*, which forms separate sheaths for them. On either side of the mesial line, the anterior jugular vein, C *c*, formed by the junction of numerous small veins descending from the fore part of the neck, will be seen to turn outwards beneath the sternal part of the sterno-mastoid muscle, A, where it pierces the deep cervical fascia covering the internal jugular vein, U, and enters that vessel, or the subclavian, near their junction.

In order to gain a view of the very important parts occupying this situation, it will now be found necessary to remove the structures above noticed. This may be done by dividing the several muscles at their middles, and turning aside their lower halves. The dense cervical fascia will thereby be exposed, stretching beneath those muscles across the episternal region, and as it covers the large vessels, will have to be dissected off. On removing this fascia, and carefully clearing the part of the subjacent cellular adipose substance, we find occupying the mesial line in front of the trachea, M, Plate III., a rounded mass, the thyroid body, L, which depends almost to a level with the upper end of the sternum, and conceals (especially when of larger size than usual) by its outer borders the common carotid artery, H, of either side. By turning aside the thyroid body, we find the trachea, M, lying central, entering the thorax behind the sternum, and nearly touching the posterior upper margin of that bone. Close on either side of the trachea will be noticed the two common carotid arteries, H H, separated from each other at a distance corresponding with the width of the trachea; which latter, in the adult, measures about three quarters of an inch in diameter. Where the two vessels appear behind the upper end of the sternum, the interval at which they are separated is less than the width of the trachea, for they incline here a little in front of that tube. On the right of the trachea, opposite to the right sterno-clavicular junction, the carotid of that side will be seen springing with the subclavian artery from a common trunk, N,—the innominate artery. About half an inch (more or less) external to the sterno-clavicular junction, appears the internal jugular vein, K, descending to join the subclavian vein. The latter vessel will be noticed lying parallel with the inner third of the clavicle, and close behind that bone. In the interval, bounded by the carotid artery inside, the jugular vein outside, and the innominate vein below, appears the first part of the subclavian artery, having the vagus and some branches of the sympathetic nerve in front of it. The right vagus nerve descending this interval, closer to the carotid artery than to the jugular vein, sends its recurrent branch looping around the subclavian artery; which branch, ascending to the larynx, will be found behind the carotid, and occupying the furrow between the trachea and œsophagus. On the left of the trachea, and behind the left sterno-clavicular articulation, we observe the carotid and subclavian arteries emerging from the chest, distinct from each other, and having the vagus nerve descending between them. The recurrent branch of the left vagus nerve, though derived within the chest, occupies in the neck a position similar to the right recurrent nerve. On separating the jugular vein still more from the carotid artery, the subclavian artery will be noticed to give off numerous branches, two of the principal of which course in reference to the region under notice. The thyroid axis is a short vessel arising from the anterior surface of the subclavian and dividing into three branches, one of which turns inwards behind the common carotid, and is distributed to the thyroid body. The internal mammary, derived from the lower surface of the subclavian, enters the thorax behind the cartilage of the first rib, W, and descending vertically behind the other costal cartilages, gives off intercostal and other branches in its course, and terminates in the diaphragm, near the lower end of the sternum. The branches of the two internal mammary arteries inosculate with each other behind the sternum, and with the intercostal arteries laterally. The two inferior thyroid arteries inosculate in the thyroid body.

The parts situated on both sides of the cervical mesial line are similar in kind and in relative position. But within the sterno-clavicular junctions, the main vessels entering the heart and issuing from it present some features exceptional to the symmetrical form. In order to expose them fully, it becomes necessary to remove the costo-sternal fore-part of the thorax, together with the inner thirds of the clavicles. After having severed the clavicles and the ribs along the costo-chondral points of union, we find, on raising the pieces together from the thorax, the pleura adhering to their under surface, and requiring to be cut for their removal. This being accomplished, the interiors of the two pleural sacs lie open, with the lungs collapsed and the heart between. Before dissecting the mediastinal parts of the pleuræ from the heart and vessels which they enclose, if the fingers be passed upwards within the pleural sac as far as its summit to the inner side of the first rib, W, we may feel the subclavian artery, the innominate artery, and the innominate vein, through the membrane, if those vessels have been injected. About midway between the origin of the aorta itself and that of its first branch, the pericardium becomes adherent to the great vessel forming its outer cellular coat. In a similar way the pericardium invests the venæ cavæ, entering the right auricle, and thence, as a simple continuation of this membrane, may be traced that which forms the outer covering of all the bloodvessels of the body, just as we find the lining membrane of those vessels to be an extension of that which lines the cavities of the heart. As distinct from both membranes will be found that which lines the pericardium, and invests the heart, and which forms, like the pleura, a closed serous sac, having its line of reflexion corresponding with the points where the

FIGURES OF PLATE III.

A. Right ventricle of the heart. — A *a*. Pericardium. — B. Origin of pulmonary artery. — C C*. Ascending and transverse parts of the aortic arch. — D. Right auricle. — E. Remains of ductus arteriosus. — F. Superior vena cava. — G G*. Left and right innominate veins. — H H. Right and left carotid arteries. — I I. Right and left subclavian veins — K K. Right and left internal jugular veins. — L. Thyroid body. — M. Trachea. N. Innominate artery. — O O. Right and left subclavian arteries. — P. Anterior scalenus muscle. — Q. Deltoid muscle. — S. Clavicular part of trapezius muscle. — R. Great pectoral muscle, cut. — T. Brachial plexus of nerves. — U U. Second pair of ribs, cut. — V V. Clavicles cut and depressed from their place. — W W. First pair of ribs, cut. — X X. Fifth pair of ribs, cut. — Y Y. The mamillæ. — Z. Lower part of sternum.

pericardium blends with the origins of the venæ cavæ and both aortæ. Having parted the pleura from the median line, opened the pericardium, and removed the cellular membrane from the primary vessels, these will appear holding the following relative position: The aorta, C, springing from the left ventricle, and having the root of the pulmonary artery, B, in front of it, arches upwards to a level with the sternal ends of the second ribs, lying oblique to the median line, and having the rise of the arch anterior in the thorax immediately behind and towards the right of the sternum, while the fall of the arch is on the left of the spine, on a level with the third dorsal vertebra. The innominate artery, N, arising from the fore-part of the arch, consequently occupies a plane anterior to that of the left carotid artery, H, which springs next in order, while the latter vessel appears anterior to the left subclavian artery, O, which arises from the posterior deeper part of the arch. These vessels, ascending in this relative position to the episternal region, appear here also at different depths from the anterior surface, those on the left side being deeper than that on the right. The superior vena cava, F, will now be seen descending to the right auricle, close to the right side of the first part of the aortic arch, and between the latter vessel and the mediastinal side of the right pleura. The right phrenic nerve descends close to the outer side of the vena cava, while the left phrenic descends in apposition with the left side of the aortic arch and the left ventricle. On tracing the vena cava upwards, we find it formed by the junction of the right and left innominate veins, G G, in front of the root of the innominate artery. The right internal mammary vein generally joins the upper end of the vena cava. The right innominate vein is much shorter than the left, the latter having to cross from the left side in front of the aortic branches to join the right vein. Each innominate vein is formed by the union of the subclavian and internal jugular veins of its own side, the union taking place on the inner border of the anterior end of the first rib, W, in front of the anterior scalenus muscle, P, close behind the sternal end of the clavicle, and outside the accompanying arteries. While thus considering the disposition of these vessels in regard to the median line, we discover in what respect they form exceptions to the general condition of symmetry; for now the single innominate artery appears to represent the two arteries (subclavian and carotid) of the opposite side, whereas the superior vena cava, on the right of the median line, has no counterpart on the left. Like the primary vessels, the vagus nerve on one side of the median line presents some features different to those of the other; thus the right vagus, descending between the subclavian artery and vein, sends its recurrent branch around the artery, and passes obliquely backwards and downwards, close to the outer side of the innominate artery, to gain the root of the lungs and the œsophagus, while the left vagus, descending between the aortic ends of the left carotid and subclavian arteries, behind the left innominate vein, gets into apposition with the right side of the aortic arch, and around this sends its recurrent branch to the larynx. Each vagus and the phrenic nerve of its own side will be found between the mediastinal pleura and the pericardium, where the latter membrane invests the origins of the aortæ. With respect to the lymphatic system, it for the most part exhibits the symmetrical arrangement, and maintains this even in the region under notice; for whilst the principal vessel (thoracic duct) of the left side enters the left innominate vein at the angle of union between the jugular and subclavian vein, that of the right side enters the veins of that side at a corresponding point.

The relative position of the primary vessels and nerves above noticed is such as ordinarily obtains. But besides those normal peculiarities of form which we have seen them to exhibit on either side of the median line, there are those of an abnormal kind, and of by no means unfrequent occurrence, which, in a practical point of view, are very important to be remembered. These attach chiefly to the arteries. The level to which the top of the aortic arch rises varies considerably, being in some instances as high in the thorax as the first costal cartilages; in others, as low nearly as those of the third ribs. According to these varieties of position will happen varieties as to the length of the primary arteries between their origins in the aorta and the level of the clavicles. The point at which the innominate artery bifurcates varies very frequently, and of course, in such cases, the length not only of that vessel itself, but of its branches (subclavian and carotid), will be found to vary accordingly. Sometimes the innominate appears dividing at an inch or even more above the line of the clavicle. Other times, that vessel is found to divide close to its origin in the aorta. Between these points, which mark the extremes, the vessel varies as to length in all degrees. The two arteries of the left side present in like manner their own varieties. These vessels ordinarily appearing with distinct aortic origins, are frequently found to coalesce and become one, simulating very closely the innominate on the other side. When either of the vessels require a ligature, such circumstances, it will be obvious, must greatly influence the issue of that operation.

On comparing the carotid and subclavian arteries on either side of the median line, with a view to estimate their respective conditions as more or less favourable for deligation, we find, that whereas those on the left lie deeper than those on the right, the former being of the two more complicated than the latter, those on the right are shorter by the measure of the innominate, from which they spring, than those of the left, which have separate aortic origins. Judging from these facts, it appears to me that those of the right side are less favourably circumstanced for such operation than those on the left, and for the following reasons:—1st, If an aneurism affect either the right carotid or subclavian near its origin from the innominate, it becomes necessary to tie the latter vessel and so cut off the circulation, as well of the branch which is sound as of that which is diseased, whereas the separate condition of the two left arteries allow of that alone being tied which is diseased. 2nd, The force of the current issuing from the heart through an artery like the innominate, of so large calibre, and situated directly above the left ventricle, is more likely to disturb a ligature than the force of that current through either of the smaller left vessels, situated as these are more remotely from the ventricle and receiving its impetus indirectly at a second angle. 3rd, The spaces occupied by the right and left vessels respectively being of equal area, the fact of the right vessels presenting in the condition of a common trunk dividing into branches, must necessarily render each of the three shorter than either of the two left vessels, and experience proves that the shorter the vessel the less likely is the operation of deligation to succeed. On the whole, I may observe, that while it appears that a longer interval of the vessel between the origins of large branches, coupled with a less degree of circulating force, are advantages for the operation, so the left vessels, presenting such advantages, are more favourably circumstanced for the operation than the right, which do not present them; and that when the latter happen to resemble the left vessels in form, a stronger hope for a favourable issue to the operation may reasonably be entertained.

By now replacing the fore-part of the thorax previously removed, and readjusting the several cervical muscles, &c., the manner in which they cover the primary vessels, nerves, and trachea may be correctly ascertained. Along the middle line, above the sternum, W, Plate IV., we observe the two sterno-hyoid muscles, H, overlying the thyroid body, P, and both these structures, with the intervening fascia, covering the trachea, O Q. A little external to this line, and just above the sterno-clavicular junction, V, we see the sterno-mastoid overlapping the sterno-hyoid and thyroid, and the three muscles covering, on the right side, Figure 2, the bifurcation of the innominate artery, together with the vagus nerve, X, and lower end of the internal jugular vein, U, and on the left side the same vessels in the same manner, with the exception that the innominate is here represented by two separate arteries, R T, the carotid and subclavian. The innominate artery, Figure 2, Plate IV., it will be noticed, is, for its whole extent, from a point immediately below its bifurcation, covered by the inner end of the clavicle, V, and the upper piece of the sternum, W. The accompanying innominate vein is wholly concealed by the same parts. On the other side, the corresponding vessels, R T, Figure 3, are covered to the same extent by the like parts. The great difficulty of gaining a clear view of those vessels for the purpose of deligation depends upon that circumstance. When, however, it is judged necessary to tie the innominate artery, the situation for the application of the ligature most convenient in all respects is just below its point of bifurcation, and this part is fortunately the most accessible. Taking the sterno-clavicular junction, V, as a fixed point to refer to in all stages of the operation, the vessel will be found behind that part at a depth corresponding with the thickness of the sterno-mastoid, A, sterno-hyoid, H, and sterno-thyroid muscles, J. The incision which will be found most convenient for retracting the superjacent parts from the vessel is one which would correspond with the angle formed by the clavicle and the anterior border of the sterno-mastoid muscle. The sternal parts of that muscle, and of the sterno-hyoid and thyroid, will require to be divided, as also the fascia, B *b*, stretched beneath them. When this is done, common prudence will dictate the necessity of revealing the vessel rather by the handle than the point of the scalpel. The bifurcation of the artery should now be sought for, in order to make sure of the ligature being applied below that point, and if the bifurcation do not appear above or on a level with the sternal end of the clavicle, it is either below that part or else does not exist, owing to the subclavian and carotid arteries having distinct aortic origins. In the latter case, the two vessels will have to be exposed, so as to be certain that upon that one which is aneurismal the

PL. IV.

Fig. 3.

Fig. 1.

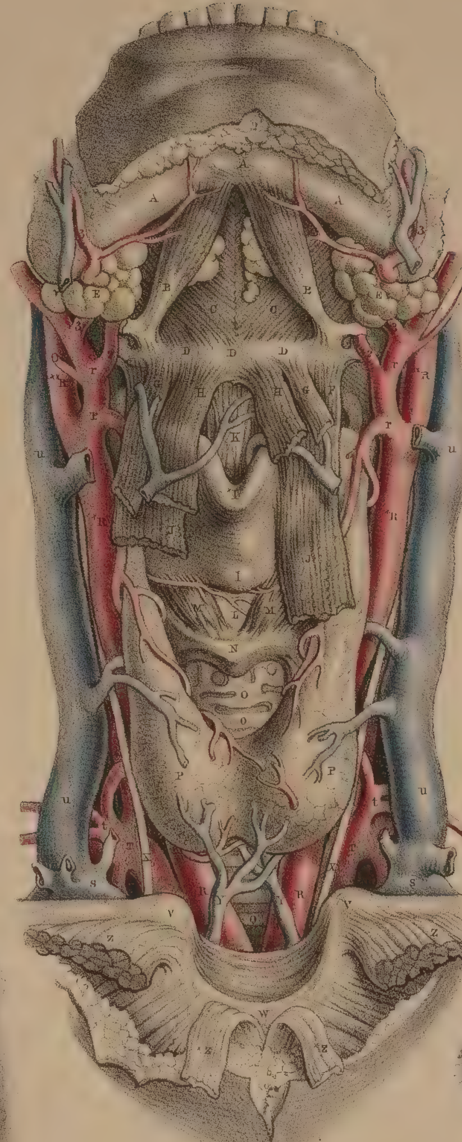
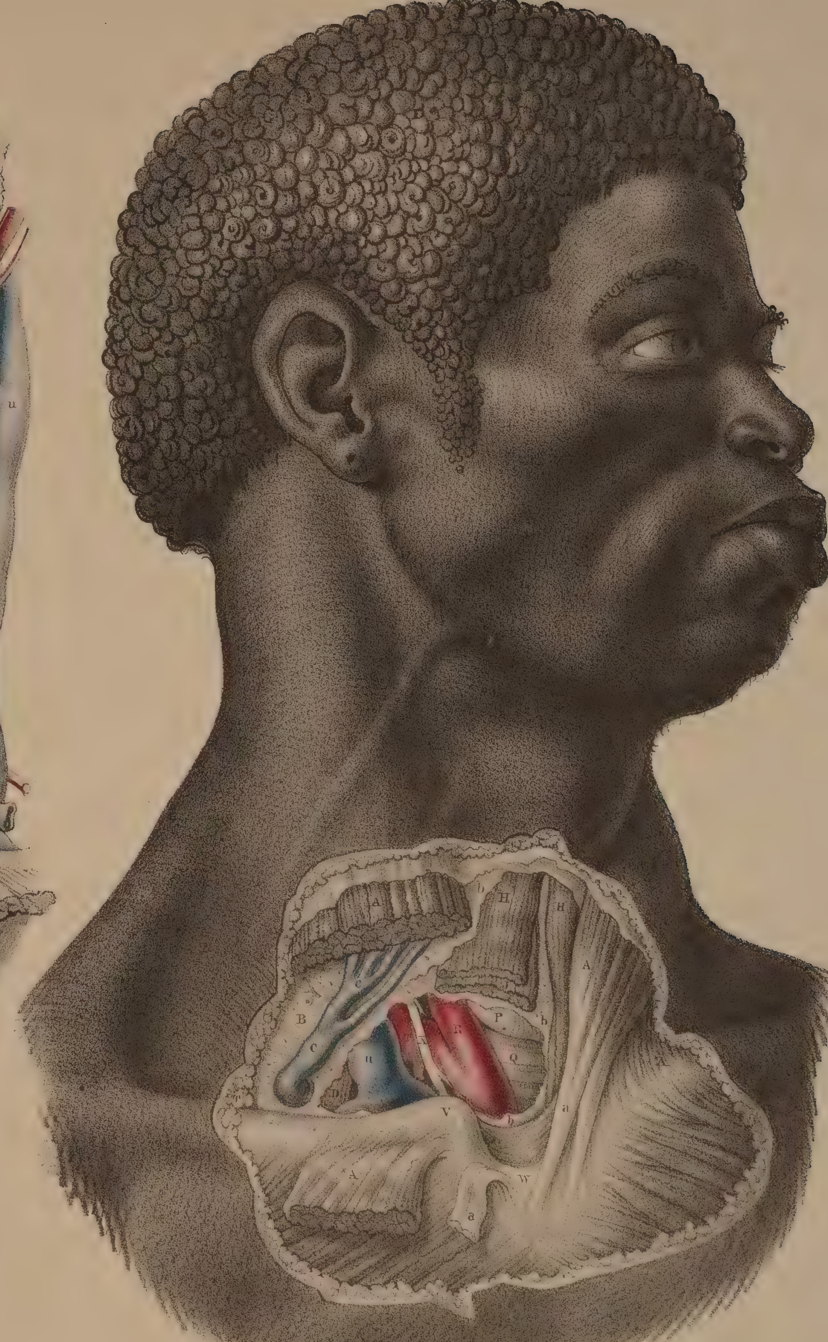


Fig. 2.



M. & E. Haubert, Impr.

ligature be placed, and, of course, on the cardiac side of the tumour. In operations upon these arteries, their most trifling deviation from the normal form is sufficient to perplex with doubt the greatest surgeons.

Among the accidents likely to involve the thoracic organs, are penetrating wounds of the thorax and fractures of the ribs. As every part of the thorax on both sides of the median line is *costal*, and lined throughout by the pleura, it will be found that wherever an instrument pierces intercostal space to a sufficient depth, both the pleura and the lung have suffered injury. The situations where the pleura and lung may be wounded, *not* through intercostal space, are at the root of the neck above the inner third of the clavicle, and at the epigastrium and hypochondrium, as thus—if the instrument penetrate downwards behind the inner third of the clavicle, it will enter the top of the lung through the pleura; and if it penetrate upwards behind the sternum or the cartilages of the false ribs, it will enter the base of the lung through the diaphragm and pleura. While the body is in the erect posture, if a small sword transfix it horizontally from below the xiphoid cartilage to either side of the eighth or ninth dorsal vertebra, it will enter the abdomen in front of the diaphragm, and enter the thorax behind that muscle. Again, if such an instrument pierce the body transversely from the seventh intercostal space on one side to a corresponding place on the other, it will traverse the bases of the two lungs in the thorax, and the summit of the abdomen between them immediately below the tendinous middle of the diaphragm; these facts being accounted for by the arching form of the diaphragm in respect to the thorax and abdomen, both as to the transverse and antero-posterior directions. The pleura lining the thorax as closely as a periosteum, will, in almost all instances, be found ruptured when the ribs have been fractured and the broken ends displaced; and in such cases, too, the lungs will generally have been injured at the same time; the latter circumstance being more likely to happen if the lung have previously been adherent to the ribs at the seat of injury. If the pleural sac be ruptured by a broken rib, the lung being uninjured and the skin entire, effusion takes place between the pulmonary and costal parts of the membrane, and separates the two from contact in a degree equal to the amount of the fluid effused, which may be either serum secreted by the pleura, or blood having its source from a ruptured intercostal artery. The amount of the fluid effused prevents to an equal extent the expansion of the lung. If the broken end of the rib rupture the pleural sac, and also the substance of the lung while the skin remains entire, then the air of the lung escapes into the sac of the pleura, producing the state named *pneumo-thorax;* and, in the same degree as the air distends the sac, the lung is prevented expanding. The air is in a case of this kind liable to enter the tissues of the thoracic walls, and produce *emphysema*, either partial or general; or it may enter the interlobular tissue of the lung itself, and render that organ permanently distended—a state as obstructive to the respiratory process as solidification or total collapse of the organ. If the pleura be freely opened from the cutaneous surface, without wounding the lung, the respiratory motions of the thorax cause the air to enter the pleural sac at the same time as the air enters the lung through the bronchi, until, after a time, the air accumulates to such a degree in the sac as wholly to obstruct the expansion of the lung. When the pleura is distended with fluid or air, occasioning total collapse of the lung, or when that organ is rendered impervious to the air by disease, the respiratory motion ceases at the side affected; in the former state the thorax appears unnaturally rounded, in the latter unnaturally flattened.

Fluid effused into the pleural sac gravitates; and therefore the operation *paracentesis*, required for evacuating it, should be performed at a part the most depending compatible with the safety of important organs and large bloodvessels. These requirements may be best secured by making the opening at the upper margin of the middle of either the seventh or eighth rib. If the operation be necessary on the right side, no organ but the lung exists in front of the instrument used, and the lung is removed to some distance from the thoracic wall by the fluid. If the left side is to be the seat of operation, the instrument enters the pleural sac behind the heart. The intercostal artery passes along the lower border of the rib, and becomes of smaller size the further it is from the spine, and the instrument is for these reasons made to enter the thorax at the upper margin of the middle of the rib selected. In cases where pus is largely effused into the serous sac (*empyema*), it may be that the lung has become adherent to the thorax at the place of operation, and under such circumstances the point of the instrument will, of course, enter the lung instead of the cavity containing the fluid. As the pulmonary and costal pleura may become adherent at various parts and in various degrees of extent, so the fluid matter will also exist pent up in various localities, forming isolated deposits, like abscesses, and this condition will necessitate our selecting other places whereat to perform paracentesis than that above mentioned. While performing this operation, care is to be taken to prevent the admission of air into the pleura on evacuating the fluid. In *hydro-thorax*, if the lung distorted by the fluid have not become bound by adhesions in such a manner as to render the distortion permanent, that organ will rise into apposition with the walls of the thorax, according as the fluid is voided, and so prevent the entrance of air. In *empyema*, the dislocated lung, if become agglutinated to the thorax in a false position, and rendered disorganized throughout its substance in consequence of disuse, will not expand as the fluid escapes, and the entrance of the air is then unavoidable. The thoracic organs exhibit occasionally some remarkable instances of dislocation occasioned by the pleuritic effusion, in one of which I have noticed that the heart, followed by the collapsed left lung, occupied in the right compartment of the thorax a position similar to what it usually has in the left.

Like other serous sacs, that lining the pericardium is liable to become distended with serous fluid, or even purulent matter, and a puncture may be required to evacuate it. As the pericardium, like the lung, is closely invested laterally by the mediastinal pleuræ, and has the sternum in front of it, it is therefore, in most cases, impossible to penetrate the pericardium without opening the pleural sac at the same time. But there exists a small space in front of the pericardium, L, Figure 1, Plate I., at which, though the pleura may be present, the lung very seldom is. This space is at the left side of the sternum, where the cartilages of the fifth and sixth ribs join that bone. The left lung here generally fails to reach the median line. For the evacuation of fluid from all parts of the thorax, the opening is recommended to be made of a valvular form, with the object of preventing as much as possible the ingress of air. To effect this form of opening, the skin is to be drawn tense to a point opposite that at which the pleura is to be entered, and having penetrated the chest at this point, and evacuated the matter, the skin, on being allowed to resume its former place, will draw the cutaneous opening aside of that in the pleura.

The parts which occupy the median line of the neck, Plate IV., Figure 1, being distinctly prominent on the surface, enable us to determine with much exactness their relative position. Those parts numbered from above downwards appear in the following order—the chin, A, os hyoides, D, thyroid and cricoid cartilages, I N, thyroid body, P, and the top of the sternum, W, the latter forming with the two sterno-mastoid muscles the episternal hollow. Between the lower jaw and os hyoides we expose (on removing the skin and cellular membrane) the anterior parts of the digastric muscles, B B, lying on the mylo-hyoid muscles, C C, of either side, the latter joining each other along the median line. In the furrows formed between those muscles and the horizontal ramus of the lower jaw may be observed the two submaxillary glands, F F, through which the facial arteries pass while sending off their submental branches. Some lymphatic bodies and branches of nerves will also appear lying on the mylo-hyoid muscles under the chin. On a level with the upper margin of the thyroid cartilage the two carotid arteries bifurcating give off at this point the two superior thyroid branches to the thyroid body. The carotid arteries will be now seen to lie close to the sides of the trachea

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FIGURES OF PLATE IV.

Figure I.

A A A. Mental symphysis, and horizontal ramus of lower jaw. — B B. Anterior parts of right and left digastric muscles. — C C. Right and left halves of mylo-hyoid muscle. — D D D. Os-hyoides. — E E. Sub-maxillary glands. — F. Thyro-hyoid muscles. — G G. Omo-hyoids, cut. — H. Sterno-hyoids, cut. — I I. Thyroid cartilage. — J J. Sterno-thyroids, cut. — K. Thyro-hyoid membrane. — L. Crico-thyroid membrane. — M M. Crico-thyroid muscles. — N. Cricoid cartilage. — O O. Upper rings of trachea. — P P. Lobes of thyroid body. — Q. Trachea. — R R. Right and left carotid arteries. — S S. Innominate veins. — T T. Right and left subclavian arteries; *t t*, thyroid axes. — U U. Right and left internal jugular veins. — V V. Sternal ends of clavicles.—W. Top of sternum. — X. Right and left vagus nerve. — Y Y. Inferior thyroid veins. — Z Z. Clavicular and sternal tendons of sterno-mastoid muscles.

Figures II. & III.

All the parts, except the following, are marked as in Figure I.:

A A*. Sterno-mastoid, cut. — A *a*. Sterno-mastoid, entire. — B *b*. Deep cervical fascia. — C *c*. Anterior jugular vein. — D. Anterior scalenus muscle.

below, and as they ascend to a level with the larynx to be here separated from each other at a much wider interval, at the same time having the laryngeal pieces projecting prominently forwards from them. Those two vessels, besides diverging in their ascent, recede from the fore-part of the neck backwards, while the laryngo-tracheal apparatus, occupying a central position between them, will be noticed to taper towards the root of the neck in descending, and to recede from before backwards. On a level with the top of the sternum, the trachea passes deeply between and behind the plane of the two carotids, whilst lower down behind the sternum, the innominate and left carotid approaching, overlie the fore-part of the tube. The trachea near the sternum is said to incline rather to the right side of the median line; but this appearance is owing to the circumstance of the innominate artery lying in front of it. Viewing these general relations of the larynx and trachea, it will appear that the nearer to the larynx tracheotomy is performed, the less liable are the carotid arteries to be injured, provided the median line directs the operation.

Between the hyoid bone, D, and the thyroid cartilage, I, those two parts will be seen connected by the thyro-hyoid ligament, K. The lip of the thyroid cartilage projects subcutaneous; so likewise does the middle part of the cricoid cartilage, N, below the thyroid. Between the two cartilages occurs a small interval, L, closed by a fibrous membrane, and guarded laterally by the pair of small crico-thyroid muscles, M M. Below the cricoid cartilage appear three or four of the upper rings of the trachea, O O, and next, the thyroid body, P, covers the trachea nearly as low down as the top of the sternum, W. In some instances, the thyroid body exists as two distinct halves, one on each side of the trachea,—a state which is normal in the mammalia and in the human fœtus,—in others, a middle lobe (the isthmus) connects the lateral lobes at the middle line; cases have also been observed in which one-half of the thyroid body was absent, but in no instance (as far as I am aware) has this organ been found altogether wanting. In general, this organ appears as a single, thick mass, lying in front of the trachea, obviously as a necessary appendage to the vocal apparatus, and serving, as I believe, for the sole purpose of varying the diameters of the elastic air-tube under pressure of the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles.*

Considering the relative anatomy of the trachea, it must appear that the most eligible situation for performing tracheotomy, is at the middle line of the upper part of the tube, O O, where it is most superficial, immediately below the cricoid cartilage. If the operation be performed at any point below this place, the instrument will have to penetrate the thyroid body; and knowing how liable that part is to vary in size, and what large vessels (arteries and veins) permeate its substance, besides the depth at which the trachea lies behind it, the dangers thus incurred become evident. Below the thyroid body the trachea, Q, may be regarded as not safely accessible, on account of its depth, its being so closely embraced by the carotid arteries, R R, and also because of the frequency with which large thyroid arteries and veins are found to lie in front of it, those vessels directly communicating with the primary vessels of the heart. In the act of deglutition, the muscles draw the larynx, trachea, and with them the thyroid body, towards the lower jaw. Then, for the moment, there occurs an interval between the sternum and the thyroid body, at which the trachea is accessible; but still, no one who is acquainted with the relative position of the important bloodvessels occupying the episternal region, will attempt to take that momentary opportunity for opening the trachea at this interval, while the operation may be performed with more ease, safety, and in almost all cases with equal effect, below the cricoid cartilage.

For performing *tracheotomy* on the upper part of the trachea, it is only needed to make a perpendicular incision, an inch long, exactly at the median line, between the cricoid cartilage and the thyroid body. The rings of the trachea having been exposed, we may, by pressing them laterally between the fingers, render them sufficiently resistent for dividing them with the point of the scalpel. In the position indicated for this operation, no vessel of any great importance crosses the line of incision. While opening the trachea here, it can be steadied by means of the larynx; but lower down, the trachea, being more moveable, is apt to swerve from the point of the instrument, and thereby endanger the carotid vessels. In the infant, the trachea is more closely embraced by the carotids; and being relatively smaller, more mobile, and shorter than that of the adult, tracheotomy is more difficult to perform in the former subject.

Laryngotomy is performed at the crico-thyroid interval, L, which may be felt as a small depression at the median line, just below the thyroid cartilage. In this place, between the two little crico-thyroid muscles, which are covered by the sterno-hyoid, the opening may be made with little trouble, the laryngeal pieces being resistent themselves, and rendering the crico-thyroid membrane sufficiently so. A small artery derived from the superior thyroid and an accompanying vein are frequently to be found crossing the median line at this part, and are liable to be divided in the operation. In some cases, that artery is of considerable size, and capable of causing, when cut, a troublesome hemorrhage. The several pieces of the larynx being in young subjects cartilaginous, and in aged ones osseous, are circumstances having certain influences over the mode of operating. Even the upper rings of the trachea are subject to ossification in advanced life. In the thyroid body, likewise, ossific matter is liable to be deposited.

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* The use or function which I here attribute to the thyroid body appears to me to be the only one for which nature intends it. And of the correctness of that view I am myself so fully convinced, that not only do I subscribe to the general acknowledgment that all the theories hitherto broached respecting the part are false, but, I believe, that whatever others may be enunciated in future time cannot (while reason holds the balance of opinion) displace that view. The question as to the meaning of the *thyroid body* resolves itself into these two forms:—Is that organ *a gland*, and, if so, what is its special object? Or, is that organ *not a gland*, and, if not, what is its use, if it have any use? Now, to define a glandular organ becomes a difficulty if we do not limit observation to physical characters—to characters of form as subservient to a particular mode and purpose of secretion. Bichat, in his definition of *a gland*, regarded the presence of an *excretory duct* as necessary, and certainly with good reason; for if we would refrain from an indulgence in transcendental visions, this limitation is necessary; otherwise, there is not a part of the animal which may not be included in the glandular system by some character or other, thus defining the *whole animal as a glandular conglomeration*. In what part of the animal form is there not a fluid secreted different from the blood? If this function cannot be denied of any part, then, while secretion alone may characterize a structure as glandular, all parts are glandular; not excepting the spleen, the thymus body, the renal capsules, the prostate, and the *thyroid body*. But it is evident that this admission does not close the question as to the particular signification of either of those organs. Nor will it allow us to name them glands in the same sense as we apply that name to such organs as the salivary bodies, the liver, the pancreas, the kidney, the testicle, &c., which we find to be agents elaborating from the same kind of fluid—the blood, other fluids of different properties, and pouring by means of excretory ducts those fluids out on the free surfaces of membranes for special purposes not their own. With such organs as these the *thyroid body* cannot be classified, for not only has it *no excretory duct*, or other structure similar to theirs, but it may well be doubted if it secretes any *special* kind of fluid—a fluid different in any appreciable quality from that of the common cellular membrane. Or, if it does, as the microscopists would have us believe, then let us, while we are waiting for them to show a few drachms of the pure isolated thyroid secretion, and while they are in search of proofs of its being no mere hypothesis they indulge, that the *thyroid body*, outwardly resembling a gland, *is a gland*, and though ductless has its secretion "taken up by absorbents serving as ducts," let us the while examine other theories. With the glandular theory are associated the illustrious names—Vesalius, Sylvius, Wharton, Morgagni, Santorini, Bœcklen, Evertzen, Duvernoy, Lauth, Uttini, Lalouette, Gunz, Schmidtmuller, Hofrichter, Haller, Meckel, and Cruveilhier, &c.

Failing to demonstrate the *glandular* nature of the *thyroid body*, and that its office was to "lubricate" the lining membrane of the vocal apparatus, some of the moderns (Sir Anthony Carlisle) ascribed to it the function of protecting that apparatus "against vicissitudes of temperature." On this supposition no comment need be offered; and we turn to the theory of Mr. Simon. That observer, to whose researches, extending through the four vertebrate classes of animals, the respectful consideration of anatomists must be for ever due, assigns to the thyroid body the function of a "diverticulum to the cerebral circulation," and founds his theory *mainly* on the circumstance that the thyroideal arteries arise in close proximity to the cerebral. Of this view I need only say that while perusing the pages of his philosophical treatise, I could not repress the suggestion that not only do the thyroideal arteries arise close to the cerebral, but the brachial arteries do the same, and yet we do not regard the arm as a "cerebral diverticulum," though we know it to act perhaps too often in that capacity. In short, in the words of Professor Sharpey, may be read the sum of all that is at present known respecting the thyroid body—"from its general appearance to the glandular organs it has been called the thyroid *gland;* but it possesses no system of excretory ducts. *Its function is unknown;* but owing to its local connexion with the principal cartilage of the larynx, it is usually described with that organ, and has received the name *thyroid*."

From my own observations I am led to conclude that the thyroid body has a function as necessary to the production of variation of tone in the vocal apparatus, as the tongue itself is necessary to effect the variation of speech-sounds. The facts which appear to me to declare the correctness of this view are briefly these:—1st. The sound of a reed musical instrument is a *monotone* till varied by the stopkey; that key, though not *in* the instrument, is yet an integral part of it; and the same may be said of the thyroid body in reference to the *vocal apparatus*. 2nd. All animals *vocal by a laryngo-tracheal organ*, possess the *thyroid body lying upon the trachea*, which tube being elastic is susceptible of *pressure from the thyroid body, acted upon by the superimposed muscles*. These muscles, besides being voluntary, have also a *consensual motion* in reference to the *vocal organ*, and act like *fingers on the tracheal pipe through the medium of the thyroid body*. 3rd. If the thyroid were of dense resistent solid structure, it would not be so well adapted to alter the diameters of the trachea, *therefore is the structure of the thyroid a congeries of elastic cells, communicating with each other, and enveloped in a common capsule, and therefore also is it so largely supplied with bloodvessels*. 4th. The *vocal organ* undergoes a *change at puberty;* so does the *thyroid body;* and we observe an *alteration in the tone of voice* as a consequence. 5th. *Abnormal enlargement of the thyroid* (goitre) is a state occurring more frequently *at puberty*, and evidently has a reference to the *full evolution of the sexual organs* at that period. The only dangerous effect of this state is (be it well observed) *an over degree of pressure on that very organ—the trachea, on which the thyroid body, when of normal proportions, acts, under muscular pressure, as a modulator of the tone of voice*, and this, I conceive, is function important enough for the part to perform. If the view which I now promulgate respecting the thyroid body be worthy of the notice of the Physiologist, it will serve some purpose in surgery if it only shows that the part should not be regarded as a mere useless thing, from the mutilation of which by operation no detriment can accrue to the economy.

Fig 1.

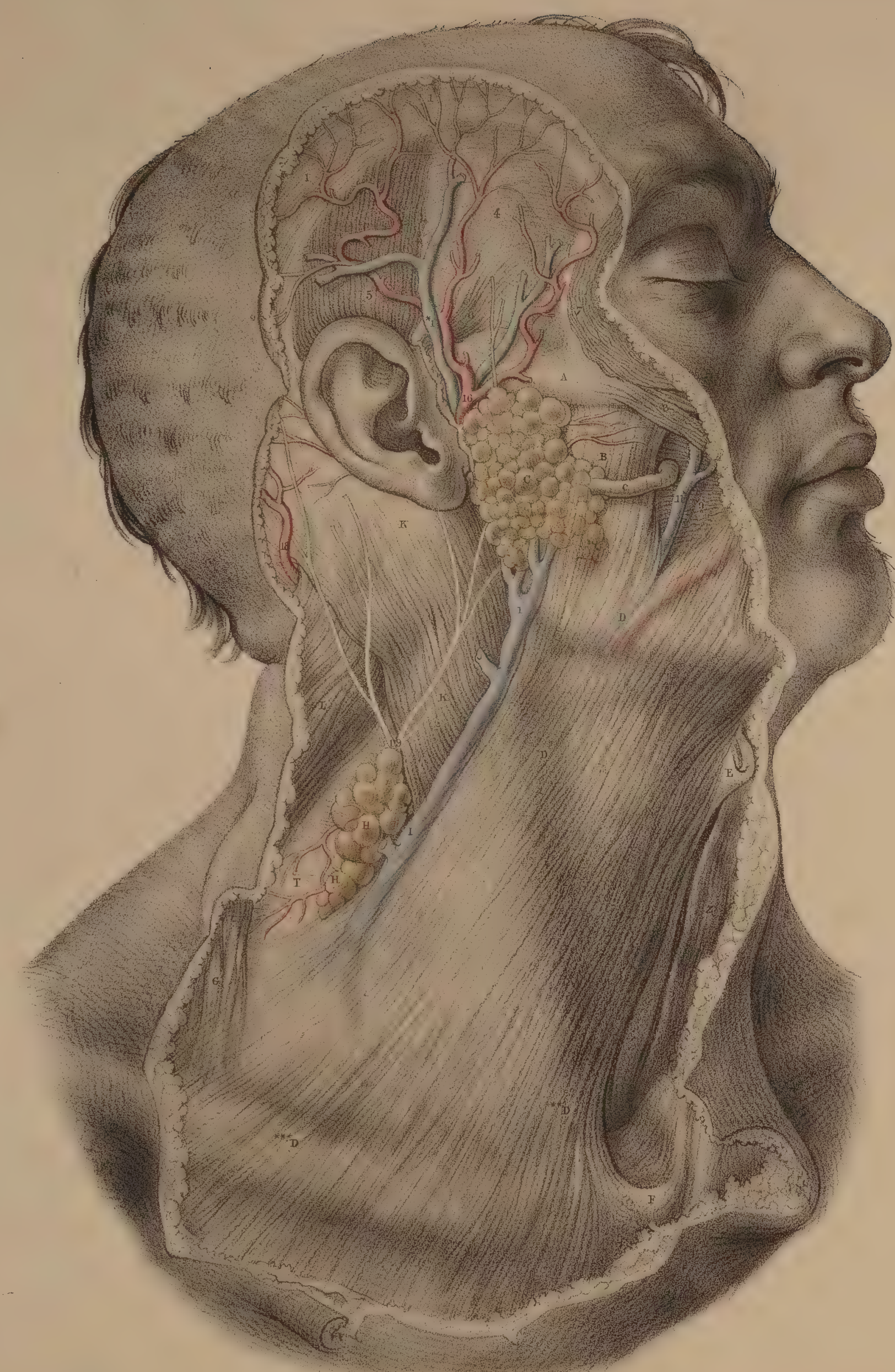
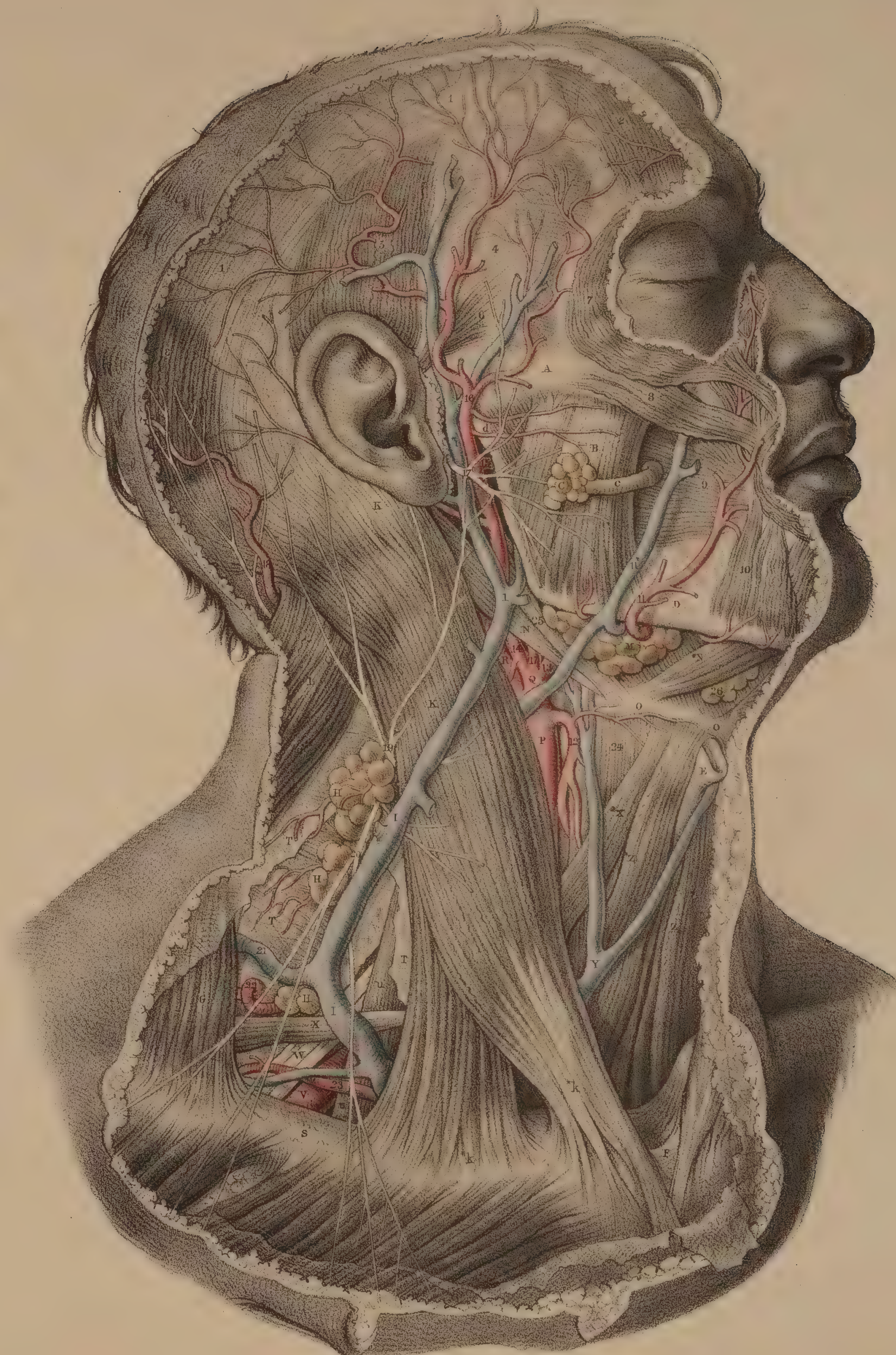


Fig. 2.



COMMENTARY ON PLATES V. VI. & VII.

THE SURGICAL DISSECTION OF THE SUPERFICIAL AND DEEP CERVICAL AND FACIAL REGIONS. DELIGATION OF THE CAROTID AND SUBCLAVIAN ARTERIES. JUGULAR VENESECTION. ARTERIOTOMY, &c.

When the side of the neck is extended, it presents a quadrilateral shape, approaching to that of a square. The boundaries of this region are formed anteriorly by the chin, larynx, trachea, sternum, and other parts occupying the median line; posteriorly by the occiput and shoulder, with the trapezius and other muscles extending between these two parts; inferiorly by the clavicle; and superiorly by the horizontal ramus of the lower maxilla, and a line produced from the angle of that bone to the occiput. The latter boundary limits the facial region inferiorly. The cervical region thus marked out is divided diagonally by the sterno-mastoid muscle, K, Plate V., into two triangular spaces—an anterior and a posterior. In the anterior space, K D E F, are situated the common carotid artery, P, Figure 2, and its branches, together with their accompanying veins and nerves. In the posterior space, K S G L, are placed the outer parts of the subclavian artery, V, Figure 2, and vein, their branches, and the brachial, W, and cervical plexus of nerves, 19-20. The forms of both these spaces are traceable beneath the integuments.

On removing the skin from the side of the neck, the face, and the upper part of the thorax, we expose the thin subcutaneous platysma-myoides muscle, D, Figure 1, which will be observed to veil almost completely both the cervical triangles. The fibres of the platysma are directed slantingly from the lower part of the face, where they blend with the muscles of expression, downwards and outwards to the upper part of the breast below the clavicle; along its posterior border, which is connected with the superficial fascia covering the posterior triangle, the subcutaneous external jugular vein, I, may be seen to descend; while anteriorly, along the median line, the platysma muscles of opposite sides approach and are connected in this situation by the superficial fascia investing the sterno-laryngeal muscles. Considering the form, extent, connexions, and position of the platysma, it would appear to serve various uses:—being attached to the skin of the face and neck, it can alter the appearance of the surface of those parts, and may hence be classed with the cutaneous muscles of expression; being stretched over the vocal apparatus, it may assist other muscles in their action for varying the tone of the voice, and may also serve to eject the secretion of the salivary glands which lie beneath it. When the platysma and superficial fascia are removed, the several parts, which, by projecting on the superficies, determine the form of the neck and face, and become as guides to the relative situations of the more important bloodvessels, nerves, &c., are brought into view. Of these parts the sterno-mastoid muscle is the principal, having, throughout its whole extent, from its mastoid origin above, to its clavicular and sternal insertions below, a close relation to the carotid and subclavian vessels.

The sterno-mastoid muscle extending between its origin and insertion diagonally through the side of the neck, is maintained in that position by the cervical fascia, which forms a sheath for it. The superficial layer of the fascia is stretched upon it; the deep layer is beneath it, and forms, in this situation, a sheath for the principal vessels. This disposition of the fascia may be best ascertained by examining it at the anterior and posterior margins of the muscle. Tracing the fascia from these points, both its layers stretching over the two surgical triangles will be found to ensheath also the adjacent muscles, and other parts. At the root of the neck, the deep layer of fascia follows the subclavian vessels under the clavicle into the axilla; and at the upper part of the neck, it forms a dense capsule for the parotid gland, C, Figure 1, behind the angle of the jaw, where it is connected with the stylo-hyoid and maxillary ligaments, and serves to protect the carotid arteries in this place. Commencing, apparently, in the parotid gland, the external jugular vein, I, will now be noticed descending obliquely backwards and downwards over the middle of the sterno-mastoid, following the posterior margin of that muscle to near the level of the clavicle, and piercing the fascia to join the subclavian vein. In this course the external jugular is accompanied by branches of the superficial cervical plexus, which may be seen to emerge from behind the middle of the posterior border of the sterno-mastoid, one of the ascending branches, 19, Figure 2, having a relation to the upper part of that vessel, while the descending branches, 20, follow its lower part. Where the vein crosses the sterno-mastoid, jugular venesection is usually performed, and in this manner:—the thumb of the left hand is to be placed on the vessel below the point which is to be opened, and the vessel being thereby steadied and distended above, an incision is to be made in it in the direction of the sterno-mastoid, thus dividing the platysma fibres transversely, which, on retracting, render the venous aperture patent. By now dissecting the superficial fascia from the sterno-mastoid and the regions before and behind that muscle, we bring partially into view other important structures.

Between the clavicular and sternal parts, *k k**, Figure 2, of the sterno-mastoid, immediately above the inner end of the clavicle, appears a small interval closed at the back by the sterno-laryngeal muscles and the deep fascia. Opposite this place, and covered by the structures now named, will be found the innominate artery dividing into its carotid and subclavian branches; towards this locality, the internal jugular, subclavian, and anterior jugular veins converge, and here also the vagus, the phrenic, and branches of the sympathetic nerve descend in front of the first part of the subclavian artery. Traversing the neck from this place, the two main arteries and their attendant veins first appear from under cover of the muscles—the subclavian vessels in the posterior triangle, and the carotid vessels in the anterior one.

The *posterior cervical triangle* is bounded by the sterno-mastoid muscle, K, Figure 2, before; by the clavicle, S, below; and by the splenius, L, and trapezius muscle, G, behind. In clearing the cellular substance from this place we meet with the ascending and descending branches of the superficial cervical plexus of nerves, the former being distributed over the occiput and about the ear, the latter to the integuments of the upper part of the chest and the shoulder. Several lymphatic bodies, H, and, near the clavicle, some large veins crossing the part in various directions to join the lower end of the external jugular vein, will also appear. The scapular division of the omo-hyoid muscle, X, may now be noticed to subdivide this space into two compartments—a superior and an inferior, in the latter of which are located the principal vessels and nerves. This inferior space, much smaller than the superior, is bounded before by the clavicular part of the sterno-mastoid and the anterior scalenus muscle, U; outside, by the trapezius muscle; above, by the omo-hyoid; and below, by the clavicle. It is in this place that the operation for tying the subclavian artery in cases of axillary aneurism is

FIGURES OF PLATE V.

Figure I.

A. The zygoma. — B. The masseter muscle. — C. The parotid gland, *c* its duct. — D, D*, D**. The platysma muscle.—E. The thyroid cartilage.—F. The sternum.—G. The trapezius muscle. — H. Lymphatic bodies. — I. The external jugular vein. — K. The sterno-mastoid muscle. — L. The splenius capitis muscle. — T. The fascia. — 1. The occipito-frontalis aponeurosis. — 4. The temporal aponeurosis. — 5. The superior aural muscle. — 6. The anterior aural muscle. — 7. The orbicularis occuli muscle. — 8. The zygomatic muscle. — 9. The buccinator muscle. — 11*. The facial vein. — 18. Occipital artery. — 19. The occipitalis minor and auricularis magnus branches of the superficial cervical plexus of nerves.

Figure II.

All parts, except the following, are marked as in Figure I.

D. The horizontal ramus of lower jaw. — M. The submaxillary gland. — N. The digastric muscle. — O. The os hyoides. — P. The common carotid artery. — Q. The external carotid. — R. The internal carotid. — S. The clavicle. — U. The anterior scalenus muscle. — V. The subclavian artery. — W. The brachial plexus. — X. The omo-hyoid muscle. — Y. The anterior jugular vein. — Z. The sterno-hyoid muscles. — 2. The frontalis muscle. — 3. The occipital muscle. — 10. The depressor anguli oris muscle. — 11. The facial artery. — 12. The superior thyroid artery. — 13. The lingual artery. — 14. The temporo-maxillary artery. — 15. The internal-maxillary artery. — 16. The temporal artery. — 17. The portio-dura nerve. — 19-20. The superficial cervical plexus. — 21-22. The posterior scapular vein and artery. — 23. The supra-scapular artery. — 24. The thyro-hyoid muscle. — 25. The stylo-hyoid muscle. — 26. A submental lymphatic body.

usually performed. In order to expose that vessel, and the accompanying nerves, &c., it is required to dissect the deep layer of the fascia, and subjacent cellular substance. This being accomplished, we now find crossing the area of this small space, besides the superficial veins and nerves already noticed, one or two large branches, 22, 23, (transversalis colli and supra-scapular,) derived from the subclavian artery, beneath the sterno-mastoid, and passing outwards to the shoulder. On turning aside these arteries, and the external jugular vein entering the fore-part of the space, the subclavian artery, V, will be seen emerging from under cover of the anterior scalenus muscle, U, having the brachial plexus of nerves, W, on its outer side, and giving off the posterior scapular branch close to the scalenus. The main artery will now be noticed to traverse the angle formed by the clavicular portion of the sterno-mastoid and the middle of the clavicle; it here appears generally for only about an inch in extent, lying deeply, and its upper part, which rests on the first rib behind the scalenus, being deeper than its lower part near the clavicle. The subclavian vein does not in this situation closely follow the course of the artery. The vein lies below the level of the upper margin of the clavicle, while the artery approaches this position from a point above that bone. The anterior scalenus muscle separates the two vessels behind the clavicular part of the sterno-mastoid—the vein lying in front of the scalenus, and between it and the clavicle.

The form of the posterior triangle is varied by the following circumstances:—When the trapezius and sterno-mastoid muscles have their clavicular attachments broader than usual, they approach each other, and so contract, or even cover the space. When those parts of the muscles are narrower than usual, the area of the space is widened. The omohyoid, when lying as low as the clavicle, or arising from that bone, as it occasionally does, covers the subclavian artery, and the shape of the locality is then obliterated, in so far as that muscle does not serve to bound it. The scalenus muscle is not subject to vary in either form or relative position. The external jugular vein has been found to descend in front of the clavicle to join the cephalic vein entering the pectoro-deltoid interval; and the latter vessel, too, has been seen to ascend over the clavicle to join the external jugular in the posterior triangle in front of the subclavian vessels; these vascular varieties are, however, very rare.

The *anterior cervical triangle* appears having its base represented by the lower maxilla, D, Figure 2; its apex by the sternum, F; and its sides by the sterno-mastoid behind and the throat before. On dissecting the fascia which covers this region we meet with the anterior portion of the omohyoid muscle, X*, which, ascending from under the middle of the sterno-mastoid to become attached to the hyoid bone, will be noticed to divide this locality into an upper and lower space in a manner similar to that in which the posterior half of the muscle divides the posterior triangle. The lower space is the episternal region already described. It is traversed by the anterior jugular vein, Y. The upper space, in which the fascia appears thick and dense, is bounded by the lower jaw-bone above; by the sterno-mastoid muscle behind; and by the omo-hyoid and anterior part of the digastric muscle, N*, in front. Here we find a number of lymphatic bodies and veins, situated chiefly along the anterior border of the sterno-mastoid on the sheath of the carotid artery. The apex of the space formed by the decussation of the sterno-mastoid and omo-hyoid is opposite the cricoid cartilage, and here the common carotid artery, P, enters it from under cover of the sterno-mastoid, and, enclosed in its sheath, which is formed of the fascia, ascends to a level with the upper margin of the thyroid cartilage, E, where it divides into the external, Q, and internal, R, carotid branches. Overlying the sheath of the carotid in this situation, the lower end of the facial vein, 11*, will be found passing to join either the external jugular on the sterno-mastoid or the internal jugular beneath that muscle and behind the carotid. When the lymphatic bodies, veins, and small branches of nerves which cover the sheath have been removed, the sheath opened, and the fascia and cellular membrane cleared from below the angle of the jaw, the more important structures here situated are in view.

The common carotid bifurcating opposite the thyro-hyoid interval will be now observed to send its branches radiating in all directions beneath the angle of the jaw. These branches, with the accompanying veins and nerves, have such numerous and complex relations as to require much care in dissection. The sterno-mastoid muscle, passing obliquely backwards and upwards to the mastoid process, leaves most of these vessels and nerves uncovered by it at this situation. At their points of origin both the external and internal carotids may be discerned, since they are alike uncovered by the muscles; but further upwards both these vessels become overlaid by the digastric, N, and stylo-hyoid muscles, 25, and by the parotid gland, C, Figure 1, in the temporo-maxillary fossa, and the sub-maxillary gland, M, Figure 2, under the angle of the jaw. The internal carotid lies deeper than the external in ascending the temporo-maxillary fossa. Here both vessels, closely followed by their respective veins, are further complicated in their relations by many important nerves—viz., the vagus, 6, Figure 1, Plate VI., descending behind them; the ninth nerve, 8, winding outside around them; branches of the fifth passing among them; the sympathetic, 5, on their inner side; the glosso-pharyngeal crossing behind them above, and the portio dura, 17, Figure 2, Plate V., crossing outside them through the substance of the parotid, a little below the condyle of the jaw. The internal carotid here ascends close in front of the vertebral column, against which part it may be compressed by the fingers. The external carotid is directed somewhat forwards from the vertebræ, and soon after its origin divides into numerous branches, to trace which it becomes necessary to remove the parotid and sub-maxillary glands. This having been done, they will be seen to pass to their destinations in the following order. The superior thyroid, 12, Figure 2, Plate V., arising from the forepart of the common carotid near its bifurcation descends to be distributed to the thyroid body, after giving a branch to the larynx through the thyro-hyoid membrane and another to ramify on the hyoid bone. The lingual, 13, which arises close above the great cornu of the hyoid bone, and soon enters the substance of the tongue, under the hyo-glossus muscle. The facial, 11, which arises with the lingual, and passes in a tortuous course upwards and forwards through the substance of the sub-maxillary gland to the lower jaw, over which it turns in front of the masseter muscle, B, to gain the side of the face, where it ramifies into labial, nasal, and orbital branches. The tortuous length of this vessel is evidently to allow of the free motions of the lower jaw. These three branches arise from the external carotid anteriorly. Three others spring from that vessel posteriorly—viz., the occipital, which passes upwards and backwards beneath the origins of the digastric, the sterno-mastoid, and splenius capitis muscles, to reappear superficial on the occiput, 18, over which it ramifies in company with the occipital nerve; the pharyngeal, which, deeply situated, ascends the temporo-maxillary fossa to the base of the skull; and the posterior aural, distributed as its name implies. The temporo-maxillary branch, 15, 16—the proper continuation of the external carotid—passes through the substance of the parotid gland in company with the vein which forms the external jugular in front of the ear. In tracing the temporo-maxillary artery through the gland, it will be seen crossed externally by the portio dura nerve, 17, which here forms a plexus, whose branches ramify upwards over the temple; forwards, over the side of the face; and downwards, beneath the lower jaw. A little below the condyle of the jaw the artery gives off the transverse facial branches superficially; the internal maxillary branch deeply to the parts in the pterygo-maxillary fossa, and the temporal branch, which, after ascending for half an inch above the zygomatic process, forms two or three principal subdivisions to ramify in all directions, anastomosing with the frontal arteries on the forehead, with the opposite temporal over the vertex, and with the post auricular and the occipital behind. The temporal artery and its subdivisions are superficial, and may be easily incised or compressed against the head in any part of their course. The facial may be best compressed where it passes in front of the masseter.

The anatomical relations of the parotid and sub-maxillary glands are so very important, that when either of these parts requires complete extirpation, some principal vessel or nerve must unavoidably be divided in that operation. But while for an injured vessel, however large, we have the remedy of a ligature and the establishment of collateral circulation, for a divided nerve there is no remedy. The portio dura nerve cannot possibly escape division, either in part or wholly, when the parotid is the subject of operation; the consequence of which will be paralysis of some or of all the muscles of expression to which the nerve is distributed. The masseter, the buccinator, and both pterygoid muscles being furnished with motor branches of the fifth nerve will of course not be affected. The orbicularis oculi muscle, supplied principally by the portio dura, becomes paralysed, though not completely so, owing to its having some terminal branches of the third motor nerve distributed to it. The parotid gland is moulded to the temporo-maxillary fossa, sinking in this place as deep as the internal carotid artery and jugular vein; its external surface is flattened, its internal surface is very irregular, and corresponds to the many different parts on which it lies. The masseter muscle and ramus of the jaw are nearly covered by the parotid, the duct of which, issuing from about its middle, crosses the masseter and turns inwards in front of the anterior border of that muscle at the buccal hollow, where it pierces the buccinator, and ends in a small orifice on the mucous membrane opposite the last molar tooth of the upper jaw. In some individuals, the parotid

Fig. 1.

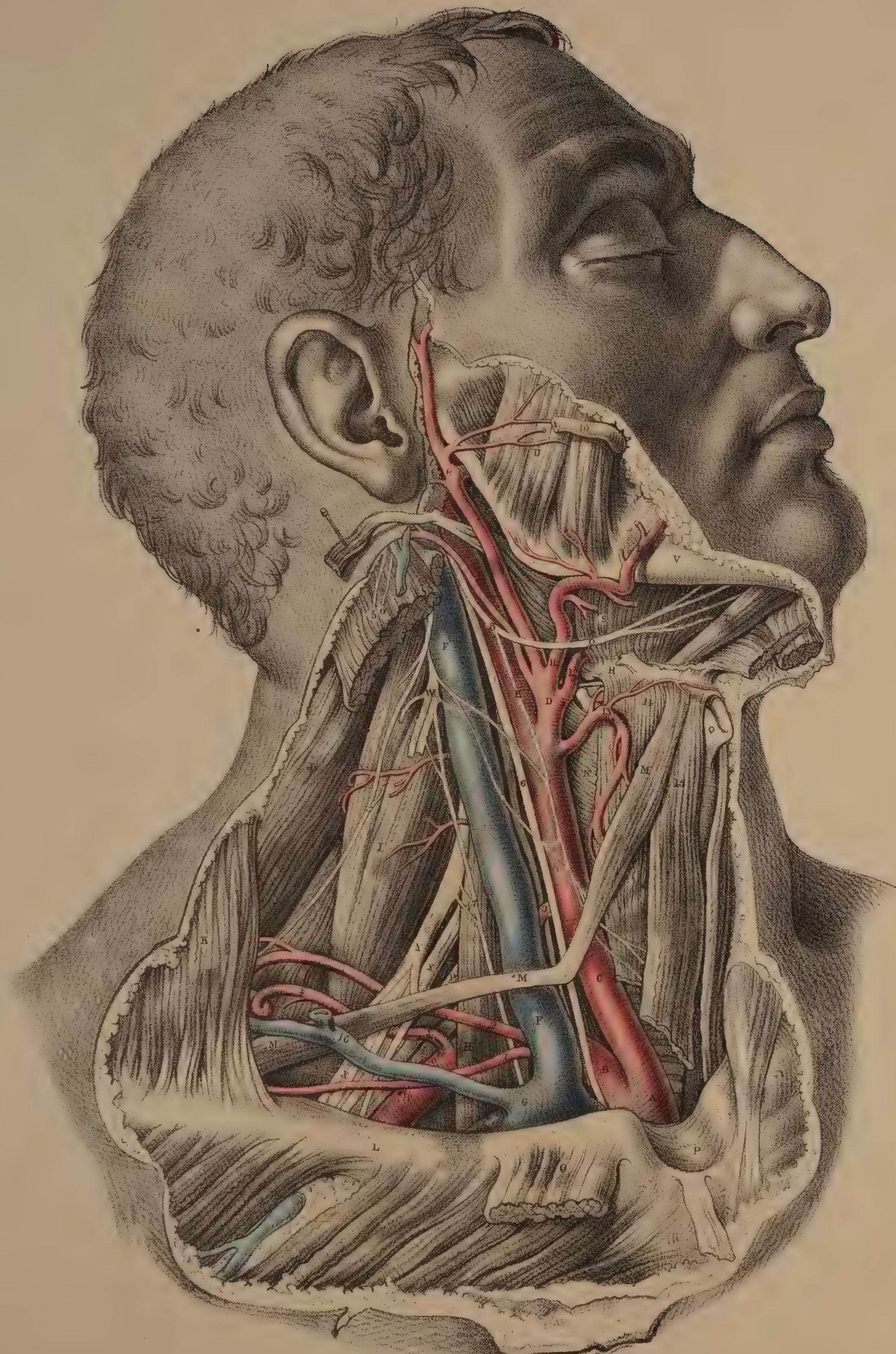
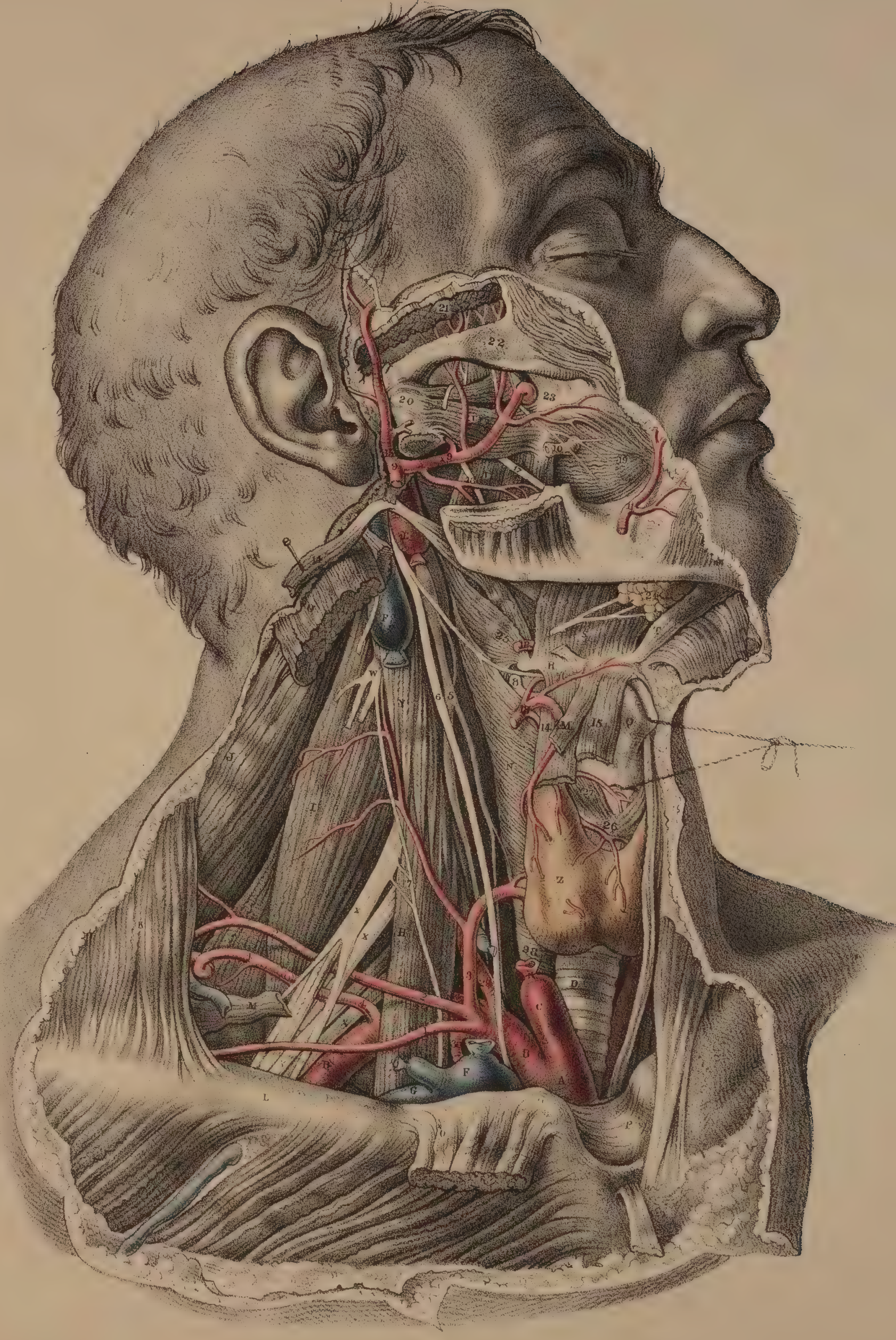


Fig. 2.



M. & N. Hanhart, Imp.

appears of unusually large dimensions, reaching backwards under the lobe of the ear, covering the upper end of the sterno-mastoid muscle, and depending below the angle of the jaw, where it identifies itself apparently with the sub-maxillary gland. In the situation of the parotid duct deep incisions should be avoided, for a wound of that duct occasions salivary fistula. The sub-maxillary gland being traversed by the facial artery, being laid upon the lingual nerve and artery where these are about to pass under cover of the mylo-hyoid muscle, and being overlaid by the facial vein, are circumstances to be remembered when that structure is the subject of operation. In close connexion with this and the parotid gland will generally be found several small lymphatic bodies, which latter, when affected with disease, may present an appearance as if the glands themselves were in that condition.

The scalp and integuments of the face are very vascular, much more so than the skin of most other parts of the body. The growth of the hair is the chief necessity for this vascularity. The face is largely supplied with nerves, branches of the sensory fifth pair and of the motor seventh pair. These form over the face a web of meshes so close that it becomes impossible not to divide some of them in making incisions here for surgical purposes. Considering the importance of the muscles of facial expression, we should, in order to avoid paralysing them, make all incisions in this situation of as limited extent as may be. The nearer the supra-orbital, infra-orbital, and mental foramina the parts are divided, the more liable to be wounded are the primary branches of the fifth nerve issuing through them. The nearer the front of the tube of the ear the incision is made, the more likely are the primary branches of the portia dura to be cut. The vessels and nerves of the scalp ramify in it over the surface of the occipito-frontalis aponeurosis. The scalp and aponeurosis are firmly adherent and move together, while the latter is but loosely connected to the cranium. As the aponeurosis covers the entire surface of the vertex, extending between the aural muscles laterally and the frontal and occipital muscles antero-posteriorly, so matter when formed between this structure and the pericranium should be voided by timely incision, lest it spread, breaking up the loose meshes of the cellular tissue which connects them.

In order to expose fully the carotid and subclavian vessels with their accompanying nerves, it is required to remove the sterno-mastoid, the lower parts of the sterno-laryngeal muscles, and the fascia beneath them. The sterno-mastoid muscle having been removed, we notice that the anterior and posterior triangles into which it served to divide the neck, appear thrown into one common region. Plate VI., Figure 1. The fascia may be now traced continuous over all parts of the neck, from the mesial line in front to that behind; and from the clavicle to the lower jaw. In a distinct sheath of the fascia, the omo-hyoid, M, like all the other muscles, will be seen enclosed, and still holding its position in subdividing the surgical spaces, as already described. The tendon, M*, which connects the scapular and hyoid portions of that muscle, passes over the carotid vessels, through a loop of the fascia, in which it moves freely, and by which it is so bound down, that its anterior part forms nearly a right angle with its posterior—an anatomical feature similar to that exhibited by the digastric muscle looped to the hyoid bone above, and evidently for a similar purpose; the action of both muscles antagonising, the latter in elevating, the former in depressing the larynx, in deglutition, and vocal motion. Along a line, reaching from the temporo-maxillary fossa to the sternal end of the clavicle, if the fascia be now carefully slit open, and its cut margins turned aside, the carotid vessels, F E D C, with the vagus nerve, 6, between them will be exposed, and their sheath seen to be formed of processes of the fascia disposed around and between them, thus separating them from each other, and at the same time encasing them in a common envelope. To expose the subclavian vessels, B G, it will be necessary to divide the fascia, between the sternal end of the clavicle and the middle of that bone, L. This being accomplished, and the subjacent cellular substance removed, both pairs of vessels may now be considered at one and the same view, in their entire extent, and their general and special relations noted with more practical advantage than could be derived from examining each separately. The diagonal line which the sterno-mastoid described in the neck, is now represented by the carotid vessels themselves, reaching between the sterno-clavicular junction and the temporo-maxillary fossa. In having this course, the carotid vessels traverse that line which represented the posterior side of the anterior triangle, and the anterior side of the posterior triangle; and, occupying thus the junction line of both spaces, their true position, in regard to the anterior one, can be correctly estimated. On replacing the sterno-laryngeal muscles, they will be seen to cover the first part of the common carotid, and if the sterno-mastoid be also replaced, it will be noticed to conceal the whole length of the internal jugular vein, F, and the two lower thirds of the carotid, E C. From these remarks it will appear, that to describe the carotid artery as coinciding with the posterior boundary of the anterior triangle, is more likely to lead to the exact position of that vessel when it becomes the subject of operation, than to say that it is contained in that space. In regard to the anterior mesial line, too, it will be further observed, that the carotid vessels, by receding from it in the same degree as they ascend the neck, cause a much greater interval to occur between them and the front of the larynx than exists between them and the top of the sternum; owing to which fact it is, that these vessels so often escape injury in the suicidal act. In the female, whose larynx is naturally smaller than that of the male, the difference as to the intervals now mentioned is not so great; while in the infant the larynx is of such small size, that it scarcely projects beyond the plane of those vessels. Such being the general relations of the carotid vessels, those of the subclavian may be noticed with them.

The subclavian vessels first appearing, like the carotid, opposite the sterno-clavicular junction, will be seen to take a course outwards in relation to the clavicle, which represents the base of the posterior triangle. If the sterno-mastoid be now replaced, it will show, that the angle formed by that muscle and the clavicle nearly corresponds in degree and position with the angle formed by the subclavian and carotid arteries, and still more nearly with that formed by the subclavian and internal jugular veins. The clavicle, L, being placed horizontal, the relative position of the subclavian vessels in respect to it may be best estimated; for now the artery, B, in passing from the sternal end to the middle of the clavicle is seen to arch to a higher level, and also to bend to a deeper plane than the inner surface of the bone represents, while the vein, G, situated immediately behind the bone, occupies the same level as it. This difference between the relative position of the subclavian artery and vein, is owing to the position of the first rib, and also to the fact, that the anterior scalenus muscle, H, separates the two vessels. The vertebral end of the first rib being higher in the neck than the clavicle, while its sternal end is lower than the clavicle, so the artery passing over the middle of the rib appears higher than the vein which rests on its sternal end. The scalenus being inserted into the middle of the rib, while the inner and outer parts of the artery, B B*, are on a plane anterior to the front surface of that muscle, so the artery in passing behind the muscle describes an antero-posterior bend from the vein which lies in front of the muscle. It is owing to the subclavian artery being elevated by the rib, that that vessel outside the scalenus traverses the posterior triangular space, and may be said to be contained therein; but though the artery deviates from the direction of the clavicle, which represents the base of the space, it will be found in practice always safer to make search for the vessel in reference to that bone, than to any of the other super-

FIGURES OF PLATE VI.

Figure I.

A. Innominate artery. — B. Subclavian artery, its first part, B* its third part. — C. Common carotid artery. — D. External carotid artery. — E. Internal carotid artery. — F. Internal jugular vein. — G. Subclavian vein. — H. Anterior scalenus muscle. — I. Posterior scalenus muscle. — J. Splenius muscle. — K. Trapezius muscle. — L. Clavicle. — M. Omo-hyoid muscle. — N. Pharynx. — O. Sterno-mastoid muscle, cut. — P. Sternum. — Q. Thyroid cartilage. — R. Os hyoides. — S. Hyo-glossus muscle. — T. Genio-hyoid muscle. — U. Masseter muscle. — V. Lower maxilla. — W. Superficial cervical plexus, cut. — X. Brachial plexus. — 1. Supra-scapular artery. — 2. Transversalis colli artery. — 3. Inferior thyroid artery. — 4. Posterior scapular artery. — 5. Spinal accessory nerve.. — 6. Vagus nerve. — 7. Phrenic nerve. — 8. Hypo-glossal nerve. — 9. Temporo-maxillary artery. — 10. Parotid duct. — 11. Facial artery. — 12. Lingual artery. — 13. Superior thyroid artery. — 14. Sterno-thyro-hyoid muscle. — 15. Sterno-hyoid muscle. — 16. Post scapular vein.

Figure II.

All the parts except the following are marked as in Figure 1.

D. Trachea. — U. External pterygoid muscle. — V. Internal pterygoid muscle. — Y. Rectus capitis major muscle. — Z. Thyroid body. — 5. Sympathetic nerve. — 8. Laryngeal branch of vagus. — 17. Gustatory nerve. — 18. Inferior maxillary nerve. — 19. Buccinator muscle. — 20. Condyle of lower jaw, cut. — 21. Temporal muscle, cut. — 22. Malar bone. — 23. Upper maxilla. — 24. Sublingual gland. — 25. Middle constrictor of pharynx. — 26. Cricoid cartilage. — 27. Crico-thyroid muscle. — 28. Œsophagus. — 29. Vertebral artery. — 30. Internal mammary artery.

ficial parts. By replacing the lower half of the sterno-mastoid, the clavicular part of that muscle will be seen to overlie the subclavian vessels between the inner end of the clavicle and the outer border of the scalenus, which latter muscle separates, by its lower end, the artery from the vein, and by its middle separates the artery from the sterno-mastoid. Between the scalenus and the inner end of the clavicle the sterno-mastoid is the only muscle which covers the subclavian vessels, and great jugular vein, F.

The general relations of the cervical vessels having been thus considered, their special relations next require notice. Close behind, and for the most part on a level with the sterno-clavicular junction, the innominate artery bifurcates into the subclavian and carotid branches, the latter vessel, A C, being the nearer of the two to the median line. From this point the carotid ascends the neck, supported in the groove formed between the pharynx, N, Figure 2, and the rectus capitis muscle, Y, in front of the vertebral column, to the carotid foramen of the temporal bone. Here the internal jugular vein, F, making its exit from the cranium through the jugular foramen, close behind the carotid, comes into apposition with the outer side of the artery, and in this relative position the vein descends the neck, supported by the same parts as the artery, to a point a little to the outer side of the sterno-clavicular junction, where it joins the subclavian vein, G, in front of the subclavian artery, and external to the innominate. In this course both vessels are enclosed in a common sheath, and between the two, in the sheath, the vagus nerve, 6, descends from the base of the skull to the root of the neck, where, with the jugular vein, it passes in front of the subclavian artery. Between the two vessels, as far down as the angle of the lower jaw, the ninth nerve, 8, Figure 1, descends, and here turns forwards in front of the artery and its branches to enter the tongue between the mylo-hyoid and hyo-glossus muscles, S. From this nerve, where it crosses the artery, a branch (descendens noni) is given off, which will be seen lying either upon the sheath, or inside it, on the artery. Deep in the furrow behind the sheath, the sympathetic nerve, 5, Figure 2, descends, giving off numerous branches, which with those derived from the vagus, the ninth, and the glosso pharyngeal, form the pharyngeal plexus. In the upper two-thirds of their course, the vessels and vagus nerve are bound in close apposition by the sheath; but in the lower part of the neck, where this structure is less defined, they are only loosely connected to each other. Behind the inner third of the *right* clavicle the jugular vein will be found nearly an inch external to the carotid artery, while midway between them appears the vagus nerve. Behind the inner end of the *left* clavicle the jugular vein lies closer to the carotid artery; and the vagus nerve descends, touching the latter vessel.

The common carotid must of course vary in length according to the level at which it arises from its parent trunk, and also according to that at which itself bifurcates. In general, the length of the *right* common carotid ranges from the sternal end of the clavicle to the upper margin of the thyroid cartilage, where it gives off the external carotid branch. Between these points it is rare to find any important branch arising from it, and hence the greater probability of a favourable result to the operation of tying that vessel. Between the origin of the external carotid and the base of the skull no branch is derived from the main vessel; but in this situation it lies so deep and so inextricably surrounded with arteries, veins, and important nerves, that this portion of it (internal carotid) becomes surgically inaccessible. The trunk of the external carotid, D, Fig. 1, Plate VI., is very seldom more than half an inch long; and in many instances it cannot be said to exist, owing to the thyroid, lingual, facial, temporal, pharyngeal, and occipital branches arising separately or in pairs from the common carotid, C, of which, in fact, the so-called external carotid, even when of its normal form, is but as an off-shoot, while the internal carotid, E, is its proper continuation. This idea seems to me to be supported by these circumstances:—1st. That the internal carotid is produced in the direction of the common carotid, the calibre of the former being little less than that of the latter. 2nd. The internal jugular vein, F, lies sidelong with both parts of the common arterial trunk, from its origin to the carotid foramen. 3rd. The common carotid relating to the *cervical vertebræ* is continued by the internal carotid which follows the *cephalic vertebræ*. Judging from these facts, the true *anatomical* signification of the "external carotid" may be expressed thus—it consists of a group of branches derived from the parent vessel, and representing as it were the *visceral* arteries of the face and neck, like the mesenteric arteries of the abdominal aorta.

Amongst the branches of the external carotid, a principal one, the internal maxillary, 9, Figure 2, parts from the temporal at the neck of the maxilla, 20, between which and the pterygoid muscles, U V, it passes forwards to the spheno-palatine fissure, 23, through which it enters the posterior nares, to be distributed to the lining membrane of the nasal cavity. To expose it, the ascending ramus of the jaw is required to be removed. In its course it gives off numerous branches in the following order—an inferior dental, which enters the dental canal; the middle meningeal, which enters the cranium through the spinous foramen of the sphenoid bone; two deep temporal, which ascend the temporal fossa under the temporal muscle; besides a buccal, superior dental, vidian, and infra-orbital branch. In dissecting this vessel, we meet with branches of the fifth nerve, two of the principal of which, the inferior dental and gustatory, 17, descend obliquely forwards between the pterygoid muscles and ramus of the jaw, the former entering the dental canal, and the latter more anteriorly passing to ramify on the tongue above the ninth nerve and the sublingual gland.

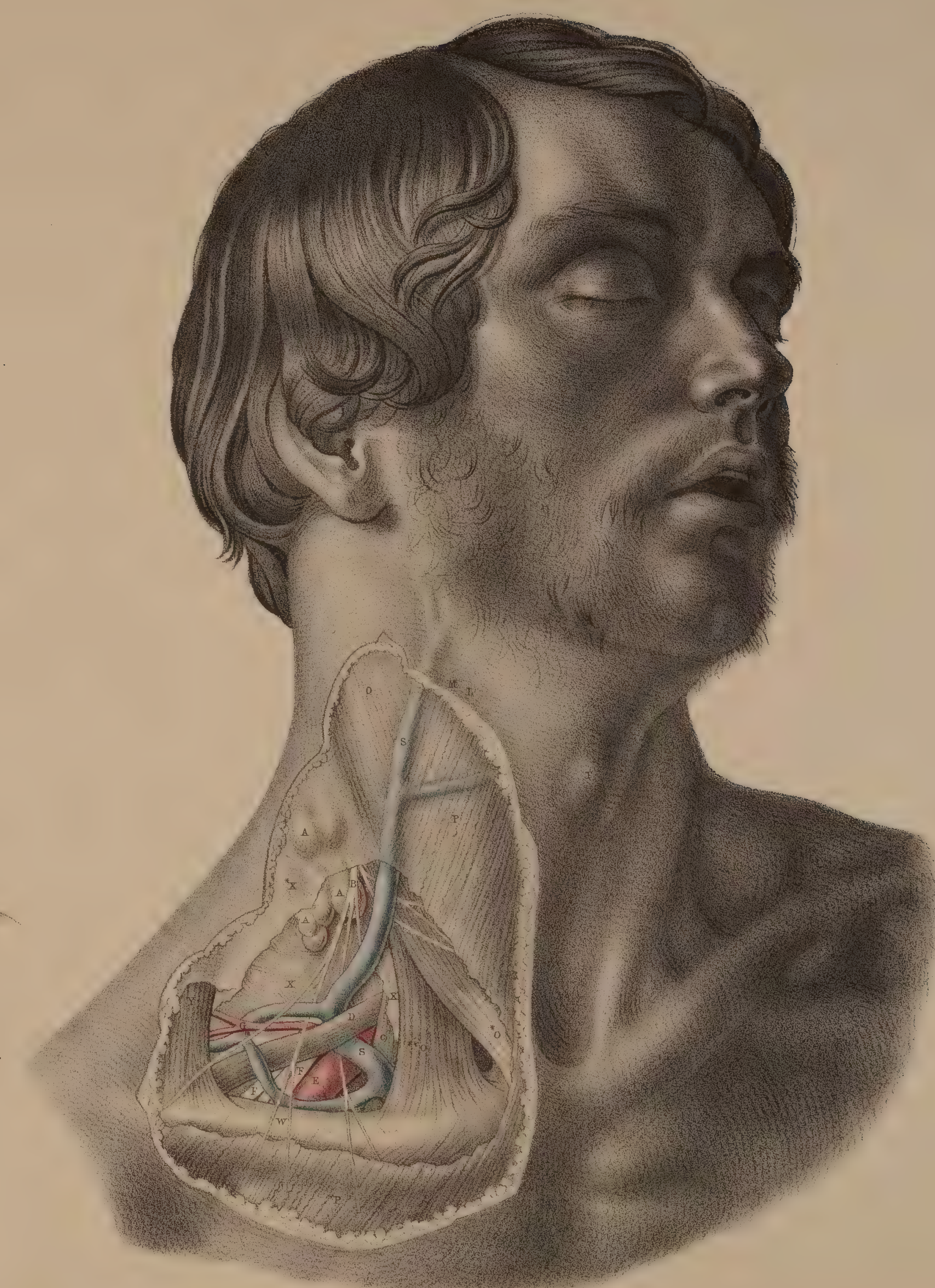
The subclavian artery arches outwards from behind the sternal end of the clavicle to the middle of that bone, beneath which it passes into the axillary space. Under the middle of the clavicle the accompanying vein parts from the artery, and passing inwards behind the bone and in front of the scalenus is joined at the inner border of that muscle by the internal jugular vein. The highest part of the arch of the *right* artery is about an inch above the clavicle, but varies in height according as the neck is short or long, the shoulder high or pendent, and also according to the position of the innominate bifurcation. Its highest part, which rests on the first rib behind the anterior scalenus muscle, is also its deepest part. The arch is divided into three surgical portions—namely, that which is internal to the scalenus, that which is behind this muscle, and that which is external to it. From each of its three parts, which are respectively very short, large branches arise, and hence the chief reason of the unfavourable results of the operation of tying this vessel when aneurismal. It is moreover crossed at all points by large and most important nerves, large veins, and even by its own branches, and hence arises the almost insurmountable difficulty of safely exposing it in that operation. Its *inner* portion, B, is in contact with the summit of the pulmonary sac, and has the vagus nerve and branches of the sympathetic in front of it, and also the lower ends of the anterior and great jugular veins. From this part of it, which is seldom more than an inch long, are given off the thyroid axis, 1, 2, 3, Figure 2, in front; the internal mammary, 30, below; the vertebral, 29, above; and the superior intercostal and deep cervical behind. From the thyroid axis three branches arise, of which one, 3, turns inwards behind the vagus nerve and lower end of the carotid artery to enter the substance of the thyroid body, while the two others, (transversalis colli, 2, and suprascapular, 1,) pass outwards between the jugular vein and scalenus muscle, traversing the lower part of the posterior triangle in front of the outer division of the main artery and the brachial plexus. The *middle* portion of the arch, little more than half an inch long, is covered by the scalenus, on which muscle the phrenic nerve descends outside the great jugular vein. Its *outer* portion, occupying the relative position above noticed, is the longest of the three, between collateral branches. Throughout its course the subclavian artery is deeply placed, as may be judged from the united width of the thick sternal end of the clavicle, the distended subclavian vein, and the fleshy scalenus muscle. These parts give the depth of the middle of the arch, but its outer and inner portions are somewhat more superficial.

The principal deviation from the ordinary relative position which the carotid vessels present is that in which the jugular vein lies upon the artery; and in this case the vagus nerve is also found to overlie it. The most remarkable deviations which have been observed of the subclavian vessels are these:—that in which the vein passes with the artery behind the scalenus, that in which the artery perforates the scalenus, and that in which the artery passes in front of the muscle with the vein. These cases are very rare. As to the brachial plexus, the only unusual feature which it exhibits is that in which one or two of its lower cords cross the artery, in front or behind, near the middle of the clavicle.

In proceeding to place a ligature around either of the cervical arteries it is required to give the neck a fixed position, in order that we may find the parts as we expect them to appear, as well in the order of superposition as occupying the same plane in each layer or stratum. The cervical vessels are liable to change of place and relations, owing to the mobility of the head, neck, and shoulder. When the neck is extended and the face turned aside, Figure 1, Plate VII., the carotid artery has generally the following relative position—the bifurcation of that vessel, K L, opposite the thyro-hyoid interval, G F, and for half an inch or more below this point projects from under cover of the sterno-mastoid muscle, O. Above this point the lower parts of the external and internal carotids are also revealed by that muscle. About midway between the os hyoides, F, and the sternum, the anterior margin of the sterno-mastoid,

Fig. 1.

Fig. 2.



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and the omo-hyoid, H, overlap the carotid; and according as we have to search for it nearer the sterno-clavicular articulation, it will be found more and more centrally overlaid by the sterno-mastoid, and also by the sterno-hyoid and thyroid, G I. The lower the situation at which we have to expose the vessel, the less do the various positions of the neck affect its relative anatomy.

When the carotid, or any of its branches, happens to be wounded, the rule is to tie both ends of the vessel in the wound. The situation of an aneurism of it must determine the point at which the ligature is to be applied to it. If an aneurism affect the internal carotid within the cranium, or immediately below the base of the skull, and the signs clearly indicate this position of the disease, the operation, whether with the object of tying the root of the internal carotid, or the upper part of the common carotid below its bifurcation, is to be performed thus:—An incision of sufficient length (an inch and a half), the mid-point of which would correspond to the level of the upper margin of the thyroid cartilage, should be made from behind the angle of the jaw along the anterior border of the sterno-mastoid muscle, dividing the skin and platysma muscle, the superficial fascia and cellular substance. The fascia forming the sheath of the artery will now, on retracting the cut parts, be exposed, and the descendens noni nerve, if lying on the sheath, may be discerned. The sheath is then to be opened along the anterior border of the vessel; and, taking care not to disturb the artery more than may be sufficient to expose the part where it is to be tied, the ligature should be carried close around it, from behind forwards, with a view to exclude the vagus and other nerves. In the same incision the root of the external carotid, L, and that of either of its lower branches, 1, 2, 3, 4, can be exposed. Recollecting that the external projects a little forwards from the internal carotid and the margin of the sterno-mastoid, the former vessel will be found close to the greater cornu of the os-hyoides, above which bone the lingual, 2, and facial, 3, arteries spring, and below which is the origin of the superior thyroid, 1. Crossing the internal and the external carotid where the latter vessel gives off the lingual and facial, we meet with the ninth nerve, 6. The parts by which the arteries are liable to be complicated in this situation are these—viz., the internal jugular vein, N, usually on the outer side of the carotid trunk, may be found completely covering it; or a number of veins, the facial vein, C, and its tributaries, may form a plexus on it; or lymphatic bodies, in greater number than usual, may conceal its position. The bifurcation of the common carotid too may be a little higher or lower than usual, and the digastric, D, and stylo-hyoid muscles, instead of both being outside the external carotid, may be inside, or else have that vessel between them.

If an aneurism arise from the carotid artery, K, opposite the thyroid cartilage, the vessel requires to be tied midway between this situation and the bifurcation of the innominate, the steps of which operation are as follow:—An incision an inch and half in length, its middle corresponding with the site for the ligature, is to be made along the anterior border of the sterno-mastoid. The skin, platysma, P, cellular membrane, and fascia, Q, having been successively divided, and the sterno-mastoid, O, exposed, that muscle, here concealing the artery, will require to be cut across its fore-part, or else relaxed by inclining the head to the sternum, in which position the muscle may be retracted from the vessel. This being done, the omo-hyoid muscle, H, will now appear crossing under the sterno-mastoid over the vessel, or it may be over the aneurism. The sterno-laryngeal muscles, G I, which, below the omo-hyoid, overlap the artery, will next require to be either divided or drawn forwards. The pulsation of the artery in its sheath, R, will now indicate its exact position. The sheath is to be slit for half an inch on its anterior side, so as to avoid the jugular vein and vagus nerve; and, with the same object in view, the ligature is to be passed close around the vessel, from behind forwards. In exposing the artery at this place, the anterior jugular vein passing under the sterno-mastoid may be found crossing the line of incision; the vagus nerve here descends close to the outer side of the artery; but the jugular vein is a little more removed from it in this direction than it is further up in the neck. For exposing the lower end of the common carotid, it becomes necessary to divide the sterno-mastoid, hyoid, and thyroid muscles, as in the operation on the innominate or first part of the subclavian artery.

As the clavicle follows the motions of the shoulder, it thereby influences materially the form and dimensions of the posterior triangle, and consequently the relative position of the subclavian artery. The shoulders of some individuals being naturally more pendent than those of others, the artery, E, Figure 2, is to a greater extent revealed above the clavicle, W, in the former than in the latter. An axillary aneurism, too, may be of so large a size as to keep the shoulder permanently elevated. But whatever be the relative position of the parts in their healthy or diseased state, it will be found that, according to the degree in which the shoulder can be depressed backwards, the greater will be the extent of the artery above the clavicle, and the more superficial also that vessel will become. The structures which overlie the vessel in the posterior triangle are the same in number and kind as those which cover the carotid in the anterior triangle; and the former vessel, like the latter, becomes more deeply situated the nearer it is to the sterno-clavicular articulation.

The outer portion of the subclavian artery requires to be tied when the vessel in the axilla is aneurismal. The operation may be performed in the following way:—The patient, lying supine, is to have the shoulder depressed as much as possible, and the head inclined to the opposite side. The position of the artery having been noted, Z O W, Figure 1, the skin is to be drawn down tensely over the clavicle, and incised upon this part for three inches, the middle of the incision being made to correspond with the middle of the bone, W, under which the artery passes. The skin being now allowed to retract upwards over the course of the artery, the incision will be found to cross that vessel; and in order to gain space in the operation, it may be deemed necessary to make another division of the skin along the border of the cleido-mastoid muscle, O. The platysma, P, cellular membrane, and fascia, X, are next to be divided to the same extent, avoiding the lower end of the external jugular vein, S, at the angle between the cleido-mastoid and clavicle, and the subclavian vein which it enters at this point. At this stage of the proceeding the parts which may appear offering impediments are these—some lymphatic bodies lying either upon the deep fascia, or beneath this in close relation to the artery—the subclavian vein rising higher than usual—veins coming from under the trapezius to join the end of the external jugular—the supra-scapular and tranversalis colli passing outwards, immediately above the clavicle—or the omo-hyoid, D, lying lower than usual. Avoiding the vessels as much as possible, or tying such of them as may happen to be cut, the omo-hyoid should now be pushed upwards, and the cleido-mastoid muscle partly divided, if broader than usual, and concealing the scalenus muscle, C. On putting the fore-finger now into the wound in search of the scalenus under the cleido-mastoid, the former muscle may be felt at its insertion into the first rib, and the artery perceived pulsating immediately behind it. On the outer side of the artery the tense cords of the brachial plexus, F, will be found with the posterior scapular branch of the artery passing backwards among them. The origin of this branch being generally close to the scalenus, the ligature, which cannot be applied above it, should be placed at a point as far below it as possible—that is, close to the clavicle, in which situation, as the subclavian vein generally lies at a little distance from the inner side of the artery, the former vessel may with ordinary care be avoided. Owing to the depth of the artery, it is found difficult to carry the ligature around it; but with the object of not injuring the vein, or including any branch of the brachial plexus, the point of the instrument should be directed under the artery from below, upwards and outwards.

The middle part of the arch of the subclavian artery is inaccessible

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FIGURES OF PLATE VII.

Figure I.

A. Masseter muscle inserted into angle of lower maxilla. — B. Parotid gland. — C. Facial vein. — D. Digastric muscle. — E. Sub-maxillary gland. — F. Hyoid bone. — G. Sterno-thyro-hyoid muscle. — H. Omo-hyoid muscle. — I. Sterno-hyoid muscle. — K. Common carotid artery. — L. External carotid. — M. Internal carotid. — N. Internal jugular vein. — O O * *. Sterno-mastoid muscle. — P. Platysma muscle. — Q. Deep cervical fascia. — R. Sheath of the vessels. — S. External jugular vein. — T. Thyroid cartilage. — U. Episternal hollow. — V O W indicate the track of subclavian artery. — W. Clavicle. — X. Hollow of posterior triangle. — Y. Projection of trapezius. — Z. Projection of sternal end of clavicle.

Figure II.

A. Lymphatic bodies. — B. Branches of superficial cervical plexus of nerves. — C. Anterior scalenus muscle. — D. Omo-hyoid muscle. — E. Subclavian artery. — F. Brachial plexus of nerves. — G. Transversalis colli artery. — L M. Place of bifurcation of carotid. — O O *. Sterno-mastoid muscle. — P. Platysma. — S. External jugular vein. — T. Projection of thyroid cartilage. — W. Clavicle. — X * X. Superficial and deep fasciæ. — Y. Trapezius muscle.

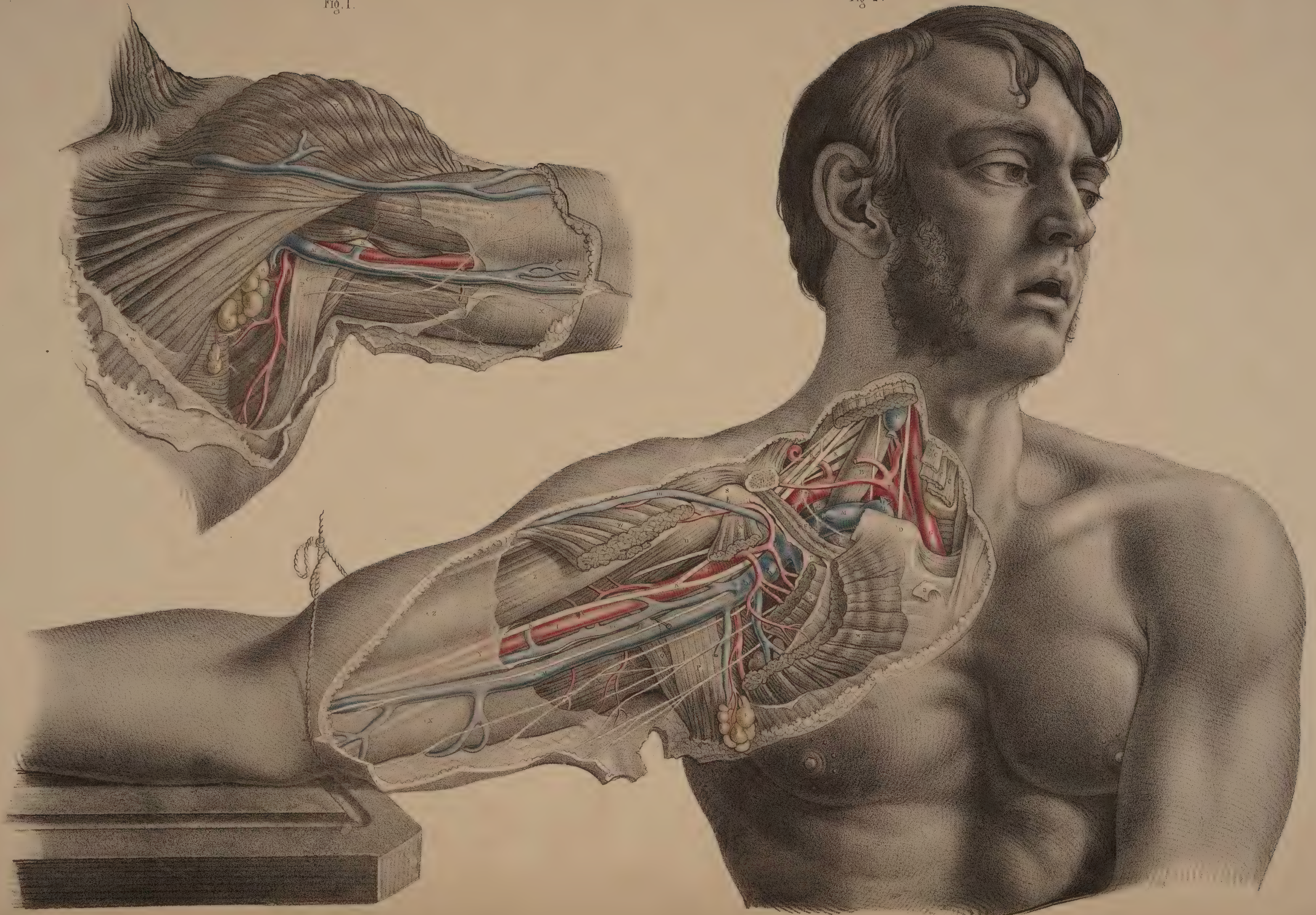
unless by dividing the clavicular attachment of the sterno-mastoid and the scalenus muscle—a proceeding which endangers the artery itself with the brachial plexus behind the scalenus, the important phrenic nerve, and the branches of the thyroid axis which pass close together in front of that muscle, and also the internal jugular vein in contact with its inner border. This part of the artery being the deepest of the three, and scarcely an inch long, between the origins of collateral branches, are additional circumstances rendering it ineligible as the site for a ligature. It has been tied in cases where the outer portion of the artery, on being exposed, was found diseased.

The inner portion of the arch of the subclavian has been tied in cases of aneurism affecting its outer portion; but in consequence of the short interval of the vessel, between its origin and the scalenus muscle, besides its great depth, the large and numerous branches which arise from it, its contiguity to the pleura, the important nerves and veins which are in front of it, and its closeness to the heart, this operation is rendered the most difficult, and is proved to be the most unsuccessful of all similar operations in surgery. As yet, it is the operation, not the disease for which it is undertaken, that has been the immediate cause of death. The operation is only performed as the least of three extreme measures—either to expose and tie the subclavian artery in this situation, attended with almost insurmountable difficulty, and small hopes of a favourable result; or else to expose and tie the innominate trunk—a proceeding equally, if not more difficult, and giving weaker hopes of a favourable issue, owing to the arrest of circulation through the carotid as well as the subclavian, besides the site of the ligature being still nearer the heart; or else to leave the case to Nature, and bide the issue of her struggle with Fate. The same parts, and in a similar manner, are required to be divided for reaching the innominate, and the contiguous parts of the two vessels into which it bifurcates. The incision which proves to be the most convenient for this operation, is one made parallel with and a little above the inner third of the clavicle, and turning upwards for about two inches along the anterior border of the sterno-mastoid. This muscle is then to be separated from its sterno-clavicular attachments, and turned aside, so as to expose the subjacent parts of the sterno-laryngeal muscles: these have next to be divided transversely; and on turning them aside, the deep fascia will next appear with the lower end of the anterior jugular vein. The fascia is now to be cautiously divided on a director, and the loose cellular substance beneath it parted with the finger or handle of the scalpel. This being done, the bifurcation of the innominate is to be sought for, and, when found, the direction of the carotid and subclavian may then be readily traced. If the subclavian artery is the one to be tied, the vagus nerve and internal jugular vein will have to be parted from each other to make way for the ligature, the more eligible situation for which will perhaps be at a point as near the scalenus as possible. The ligature here will have to its inner side all the principal branches—the thyroid axis, internal mammary, and vertebral; but it being at the greatest possible distance from the carotid, it will not be so much exposed to disturbance from the strong current of that vessel as it would be if placed more internally. In the latter situation, moreover, the ligature would be between two disturbing causes, that of the direct circulation through the carotid on its inner side, and that of the retrograde currents through the branches on its outer side. In passing the ligature around the artery, much care is required to avoid including the recurrent branch of the vagus nerve—an event which is more likely to happen while the vessel is being tied nearer the carotid than the scalenus muscle; and this remark also applies to the sympathetic nerve. In directing the point of the instrument around the artery from below upwards, it should be kept close to that vessel, so as not to puncture the innominate vein, or lacerate the pleura.

The right subclavian artery frequently varies as to its place of origin. In some instances it has been seen springing from the back part of the aortic arch, and passing behind the œsophagus, or between that tube and the trachea; in others, holding its usual position in the neck, but arising separately from the fore-part of the aortic arch, the right carotid also arising from the aorta, and the innominate being of course absent in both these instances. In others, the right subclavian was found to spring from the innominate, at the usual level, but behind the root of the carotid, and consequently on a deeper plane than ordinarily. The left carotid is frequently seen to spring from the innominate. The subclavian arteries are occasionally found complicated, by short supernumerary ribs jutting from the seventh, sixth, or fifth cervical vertebræ, and giving to this region of the skeleton an appearance similar in all respects to that where the asternal ribs degenerate into the transverse processes of the lumbar vertebræ. The carotid arteries, too, I have observed, in aged subjects, to be occasionally complicated by a shaft of bone representing the ossified stylo-hyoid ligament. One or both of these varieties in the human skeleton are normal and constant in different species of the lower animals, even in those of the class Mammalia, and thus express their meaning. Thus, indeed, by a comparison extending through the animal series, do all others of the so-called anomalies of form, whether as regards the vascular, the muscular, or the osseous system of the human body, become analysed, and manifest their proper signification.

Bloodletting is a curative measure, much oftener adopted at empirical hazard than on rational principle. The truth of this observation will be the more readily acknowledged, in regard to diseased conditions of the nervous centre. The objects of the operation are twofold—a *general* and a *local* depletion of the bloodvessels. For effecting the general depletion a vein or an artery is opened, and the blood let out in a full stream; and for effecting the local depletion the capillary vessels are divided in the vicinity of the part diseased, or in the part itself, and the blood is here made to issue through the numerous little orifices. While reflecting upon the rationale of this subject in its several bearings, the following ideas occur to me:—1st. As the vascular system forms a circle of which the heart, the prime-mover of the blood, is a point, it follows that from whichever other point of the circle we abstract blood, we induce general and local depletion at the same time. The effect, then, of local depletion cannot result but as the effect of general depletion also, and *vice versâ*.—2nd. Whether it be an artery or a vein that we open, general depletion will equally result. But the arterial and venous blood are of different quality. This being the only difference, it follows, that unless we believe the blood in the afferent artery has a more immediate relation to the diseased state than the blood in the efferent vein, there exists no reason why we should prefer arteriotomy to venesection. Even if we had reason to believe this, the choice of the former operation must be a mere myth in practice, while we find the arterial becoming transformed into venous blood, and the one to be as closely followed by the other as substance by shadow—the removal of the one fluid implying hence the removal of the other, both qualitatively and quantitatively.—3rd. The effect, then, in respect to systemic depletion being equal, whether the blood be drawn from an artery or a vein, our reasons for preferring to make the vein the subject of the operation are these:—It is always more accessible, more manageable, and less frequently attended by untoward consequences.—4th. As in every part, however small, we find a vascular circle special to it though a portion of the great circle, so every part may be regarded as possessing a life of its own, though dependent on the life of the whole. This remark is true also of the diseased state, for each part may be specially affected while involving the whole, and hence admits of special and general curative treatment. Hence for local inflammations, local bloodletting may be sufficient; and as in such cases we take no account of differences between capillary arteries and veins, which we open indiscriminately with the desired effect, so may we infer, that for general inflammations arteriotomy has no virtue to recommend it which venesection does not possess.—5th. As every part has a special main artery leading to it, and a corresponding vein leading from it, so when we require to abstract blood from a part, particularly, which happens to be out of reach, either of these vessels are to be made the subject of operation. In some instances the size and the situation of these vessels forbid this measure, and then we have recourse to general bloodletting, performing that operation at the most convenient situation. The carotid artery and internal jugular vein are the principal vessels serving the brain; but owing to their size and position, they forbid the operation on them. Now, in such cases as delirious phrenitis, and comatose congestion of the brain, though it is usual to open the temporal artery or the external jugular vein, on the supposition that as these are cephalic vessels they must directly refer to the brain, it should be remembered that this is no more true than it is of the brachial vessels, and therefore the latter being more accessible, should be preferred for the operation.—6th. When blood is once effused in the substance of any organ, it can neither be removed, nor its increase prevented, by either venesection or arteriotomy. Those operations can no more influence blood *effused* in the brain, than they can a *fracture* of the skull, with *depression*.—7th. When the functions of the brain are annihilated by *concussion*, the functions of the heart, and consequently of the whole vascular system, are electrically struck, and in a great measure abolished, at the same time. Therefore in such a case it must at once appear, that to draw blood in the hope of arousing either heart or brain would be no less vain than to discover in the demonstration *ad absurdum*, the contrary—than to raise $a - b$ to $a + b$, by still subtracting the quantity b.

Fig. 1. Fig. 2.



COMMENTARY ON PLATES VIII. & IX.

THE SURGICAL DISSECTION OF THE SUPERFICIAL AND DEEP AXILLARY AND BRACHIAL REGIONS. DELIGATION OF THE AXILLARY AND BRACHIAL ARTERIES, &c.

THE boundaries of each surgical region are but artificial, and cannot be otherwise, forasmuch as we see one region blending with another, and the same kind of structure traversing two or more of them. These boundaries being in most instances described by moveable parts, will hence be found to influence not only the form and dimensions of the region itself, but in some respects the relative position of the several structures which it contains. The clavicle is an example of this kind of conventional boundary. This bone serves to mark the ideal line of separation between the lateral cervical region and the axilla; but as it is a part which freely obeys the action of the neighbouring muscles, it will, according to its motions, be observed to vary the areas of both these regions, contracting that of the one in the same ratio as it increases that of the other. In the same degree as the clavicle happens to vary the dimensions of the cervical and axillary spaces, will it also vary the length of those parts of the main vessels and nerves which are described as being located in either space, above and below its own level. Hence the necessity for fixing this bone in the horizontal position when we would describe regions and structures whose forms, dimensions, and relative situations are, for practical purposes, allowed to be chiefly determined in reference to it. Those portions of the subclavian vessels and nerves which are above the level of the clavicle then occupy the cervical region, while those portions which intervene between this bone and the folds of the axilla, traverse the axillary region, and below the latter they become brachial.

The arm being abducted, and the skin, adipose substance, platysma, and superficial fascia having been dissected off the pectoral region and fore-part of the shoulder, we see exposed the great pectoral muscle, W, Figure 1, extending between its origin and insertion. At its origin, from the inner half of the clavicle,—the sternum, and adjacent ends of the ribs, the muscle is thin, owing to its fibres being spread over so large a surface; but where it forms the anterior fold of the axilla, W R, it presents of considerable thickness, the fibres here having become congregated, and the whole muscle so twisted upon itself, that its inferior border is turned up and folded beneath its middle part, W, Figure 2, and thereby its tendon, inserted into the anterior margin of the bicipital groove of the humerus, is concealed. A very similar arrangement of its parts is exhibited by the latissimus dorsi muscle, P, in forming the posterior border of the axilla. Between the sternal and clavicular parts of the pectoral muscle, a cellular interval will be observed, through which some of the branches of the internal mammary artery pass forwards; and between the clavicular portion of the muscle, W D, and the deltoid, V, another such interval appears, which is a feature of some surgical interest. In this situation, the cephalic vein, *m***, enters the axillary space to join the axillary vein, M, Figure 2, and here also some offsets of the acromial branch of the axillary artery, I, pass outwards, to ramify beneath the integuments. On pressing this interval with the finger, the coracoid process, S, Figure 2, may be felt as a hard body not far beneath the surface, and about an inch below the clavicle; it is deeply along the inner side of this process that the axillary artery, I, with its accompanying vein, M, and nerves, K, traverse the axilla to gain the inner side of the arm. The pectoral muscle consists of large bundles of fibres, which lie parallel, near their origin, and decussate towards their insertion; and from between them numerous small arteries are to be seen emerging to the integuments. These vessels are the terminal branches of the thoracic arteries given off from the axillary; and upon them, and the superficial branches of the internal mammary artery, the female mammary gland is solely dependent for its supply. During lactation, they become of larger size, and more numerous than at other periods. On the external border of the pectoral muscle appears the deltoid, V, forming a muscular cap for the shoulder joint, and arising from the outer third of the clavicle, the acromion process, and spine of the scapula, to be inserted near the middle of the humerus on the outer side of that bone. Viewing the pectoral and deltoid in front, they present the appearance of being one muscle, as well from the similar character of their fibres as from their serial and parallel arrangement between origin and insertion, being only separated above by the cellular interval before noticed, while below the two appear inseparable. In tracing the cephalic vein from above, it will be seen to wind along the anterior-inferior border of the deltoid and over the biceps, to gain the outer side of the arm, and to be in its whole course subcutaneous.

By removing the central third of the clavicle, D, Figure 2, and that of the great pectoral, W, together with the subjacent membrane, we expose the subclavius, F, and the lesser pectoral muscle, N. The subclavius will be seen to arise from the sternal end of the first rib, and, lying parallel with the clavicle, to be inserted into the under surface of this bone as far outwards as the coracoid process of the scapula. The lesser pectoral, below the subclavius, arises from the three or four upper ribs anteriorly, and tapers upwards and outwards to its insertion into the coracoid process. The fibres of this muscle decussate with those of the great pectoral, and form but a partial covering to the axillary space. Around its upper and lower borders some of the thoracic arteries turn forwards to enter the substance of the great pectoral, and ultimately ramify in the pectoral integument. Both pectorals, when viewed in section, will be found separately enclosed in distinct sheaths of fibrous membrane. On dividing the lesser pectoral and turning aside its parts, the deep layer of the axillary fascia comes into view, stretching from the side of the thorax to the coracoid process, and from the first rib to the humeral outlet of the axilla, where it becomes continuous with the fascia of the arm. Of this membrane is formed an irregular sort of sheath for the axillary vessels, as may be seen by dividing it along their course. This having been done, and the parts separated, the axillary space is now fairly opened, and exhibits a complicated mass of bloodvessels, nerves, and lymphatic glands embedded in a large quantity of loose and very extensile cellular substance, mixed with adipose tissue and infiltrated with serum. The more important parts having been cleared of the surrounding tissues, the main bloodvessels and nerves will be exposed, traversing the neck and axilla, whilst the relations of the clavicle and the manner in which it divides both regions may now be clearly understood. Immediately behind the inner third of the clavicle now appears the subclavian vein, M, Figure 2, crossed by a small nerve derived from the brachial plexus, and given to the subclavius muscle. Behind the vein is the anterior scalenus muscle, B, inserted into the middle of the first rib, crossed by branches of the thyroid axis, and having the phrenic nerve descending on its inner border. Behind the scalenus is situated the subclavian artery, I, arching over the first rib, E, and rising to a higher level in the neck than the vein. Above the artery may be observed the brachial plexus, K, issuing from between the two scaleni muscles, B B, attached to the transverse processes of the cervical vertebræ. In this same order, the nerves, artery, and vein arrive under the middle of the clavicle, the vein gradually approaching the inner side of the artery, while the nerves are already closely applied to its outer side, and here sinking beneath the clavicle and subclavius muscle, they enter and traverse the axillary region under cover of the parts already mentioned.

FIGURES OF PLATE VIII.

FIGURE I.

A. Trapezius muscle. — B. Serratus magnus muscle. — D. Clavicle. — I. Brachial artery. — K. Median nerve. — M *m*. Basilic vein; *m***. Cephalic vein. — P. Tendon of latissimus dorsi. — Q. Teres major muscle. — R. Axillary lymphatic bodies. — U. Coraco-brachialis. — V. Deltoid muscle. — W. Pectoralis major muscle. — X. Triceps muscle. — Z. Biceps muscle.

FIGURE II.

All parts, except the following, are marked as in Figure I.

A *a*. Sterno-mastoid muscle, cut. — B. Scalenus muscle. — C. Sterno-hyoid muscles, cut. — D. Clavicle, cut. — E. First rib. — F. Subclavius muscle. — G. Innominate artery. — H. Common carotid. — I. Subclavian and brachial artery. — K. Brachial nerves. — L. Internal jugular vein, cut. — M. Subclavian and basilic vein; *m**. Venæ comites; *m***. Cephalic vein. — N. Pectoralis minor muscle, cut. — S. Coracoid process. — T. Fascia covering axillary vessels. — Y. Sheath of the brachial vessels.

The axilla is a space of very limited area, while the arm is adducted to the side. In this position of the arm, it exists only as a small interval bounded by the two first ribs, the clavicle, and the head of the humerus. But when the arm is fully abducted, the osseous and muscular parts being entire, it exhibits much wider proportions and a more definite shape. In the latter position of the arm, the axilla appears conical in form, having its apex at the root of the neck, between the clavicle and subclavius in front, the first rib internally, and the upper margin of the scapula externally. Its base is below, looking towards the inner side of the arm, and is formed by the lower border of the pectoralis major in front, by the latissimus dorsi and teres muscles behind; while the anterior side of it is described by the two pectoral, the inner side by the thorax overlaid by the serratus magnus, and the outer and posterior sides by the scapula and humerus, together with the muscles connected to these bones. The apex of the axilla is closed by the deep cervical fascia, of which the subclavian vessels, on entering this space, carry with them a duplicature, in the form of a sheath. The base is closed by the dense fascia stretching between the axillary folds and from the side of the thorax to the arm. Here the axillary vessels and nerves pass out in close apposition with the inner side of the arm, to which they are bound by a process of the membrane last mentioned.

While clearing the axilla of the cellular substance, much care is required to preserve the numerous branches of nerves, arteries, and veins, which here cross each other in all directions. The arterial branches will all be found derived from the axillary artery; and the veins accompanying them may be traced to the axillary vein. The brachial plexus of nerves, too, while passing through the space, gives off numerous branches to the adjacent muscles; while nerves from other sources—the intercosto-humeral branches of the intercostal nerves, and the long "external respiratory nerve" of the cervical plexus—will also be found traversing this situation. The cephalic vein, *m***, entering the axilla, through the pectoro-deltoid interval, joins the axillary vein, M, below the clavicle; while the basilic vein, M**, passing upwards from the inner side of the arm, enters the base of the axilla, and after receiving the venæ-comites of the brachial artery, and others of large size, from the side of the thorax, becomes, in fact, the axillary vein itself.

In traversing the axilla, the principal vessels and nerves will be noticed to lie closer to the arm than to the thorax. Very soon after they have passed from under the subclavius muscle, they get into apposition with the coracoid process of the scapula, where they are overlaid by the upper part of the lesser pectoral muscle attached to that process, and thence they course along the inner border of the coraco-brachialis muscle, U, to the middle of the inner side of the arm, where they first come in contact with the biceps, Z. In this course the artery lies nearer to the arm than the vein, the latter vessel being somewhat apart from the inner side of the artery, especially at the level of the clavicle, and the two not coming into apposition till near the axillary folds. Both vessels will be found much deeper from the pectoral surface immediately below the clavicle, than they are when about to pass from under cover of the pectoral muscle to the arm. In the former situation, too, they are (especially the artery) much more closely surrounded by their own offsets and by the brachial plexus of nerves. The axillary vein lies parallel with and to the inner side of the artery, while the brachial nerves are in actual contact with the latter vessel, forming a plexus around it. The brachial plexus, K, Plate IX., Figure 1, does not appear to have the same form and arrangement in any two individuals, but in general it will be seen to embrace the main artery so closely as must render it a very difficult and hazardous task to apply a ligature to that vessel in the living body. On the outer side of the artery will generally be seen a large nerve, which soon divides into two branches—namely, the musculo-cutaneous, which pierces the coraco-brachialis muscle, U, to gain the outer side of the arm; and the other, which contributes, with a branch on the inner side of the artery, to form the median nerve, K 1, lying in front of that vessel in this situation. The ulnar, 2, the musculo-spiral, 3, the circumflex humeri, 4, and the subscapular nerve, lie to the inner side of the artery, and overlaid by the vein. Small thoracic nerves, derived at uncertain points from the plexus, supply the pectoral muscles; two or three intercosto-humeral nerves cross the axilla in the direction of the arm, to supply the integument of this part, while other small nerves (the internal cutaneous and Wrisberg's nerve), given off from either the ulnar or the musculo-spiral, follow in the course of the basilic vein, over the fascia, and terminate in the skin of the forearm.

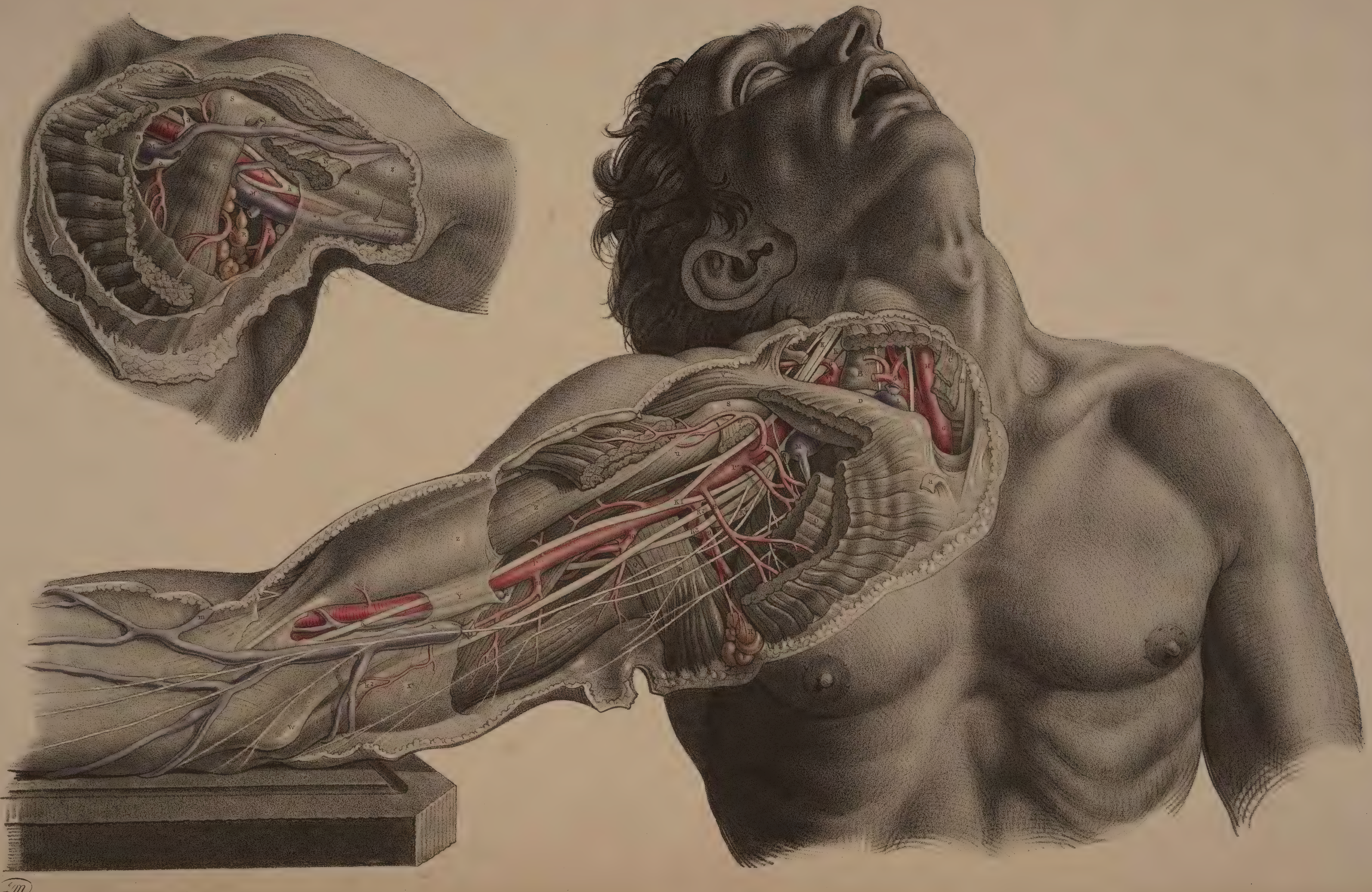
The branches derived from the main artery in the axilla are destined for the neighbouring parts, and vary as to their number, size, and points of origin. The principal of them are the thoracic, 7—8, ramifying among the pectoral muscles; the acromial, 7, turning in the course of the cephalic vein, *m***, over the coracoid attachment of the lesser pectoral muscle; the anterior and posterior circumflex humeri, taking the course indicated by their names, and passing close around the neck of the bone; and the subscapular, 9, which generally arises from the main artery, between the tendon of the latissimus dorsi and the adjacent border of the subscapular muscle, near the humerus; and having given off in this place one or two large branches to the dorsum of the scapula, descends along the border of the latissimus dorsi muscle, ramifying on it and the side of the thorax. This branch is the most constant, perhaps, of them all in respect to size and place of origin. I have, however, observed it arising from all parts of the parent vessel. The first important branch of the axillary artery is the thoracico-acromialis, 7, and the point at which it generally arises—viz., an inch or thereabout below the clavicle—may be noted with practical advantage in reference to the application of a ligature to the outer part of the subclavian. The place of origin of the posterior scapular branch, 6, of the subclavian being usually at the outer border of the scalenus muscle, it will be observed that, between this point and the origin of the first axillary branch, the main vessel presents a longer interval than, at first sight, the clavicle crossing the middle of this part would allow us to notice.

The axillary vessels and nerves in passing from this place to the arm assume the name brachial. In their course along the inner side of the arm, Plate VIII., they appear comparatively superficial, being covered only by the integuments, adipose substance, and fascia. Near the axillary folds, W, P, the artery, I, will be found passing along under cover of the coraco-brachialis muscle, U, Z, which separates it from the biceps. Not till the artery has arrived at the middle of the arm does it come into apposition with the biceps—a circumstance necessary to be remembered when operating to expose the vessel in this situation. The fascia of the arm forms sheaths for all the muscles, and a distinct one, Y, Figure 2, for enclosing the brachial artery, the median nerve, and the venæ comites, which are by it bound in company along the osseous axis of the limb. The basilic vein, M**, accompanied by the internal cutaneous nerve, courses superficial to the fascia, in the same line, however, with the brachial artery, the fascia alone separating both vessels. Between the lower border of the axilla and the middle of the arm, Plate IX., the artery appears in close relationship with the ulnar, K 2, and musculo-spiral nerves, K 3, as well as the median nerve, K 1. In this situation, the median nerve will be found lying to the outer side, or in front of the artery, the ulnar nerve being on its inner side, and the musculo-spiral behind it—the sheath alone separating the two last-named nerves from the vessel. From the middle of the arm downwards, the artery and nerves take different directions. Separating from the artery, the ulnar nerve, supported by the short inner head of the triceps muscle, and under cover of the fascia, is directed to the inner condyle of the humerus, W, behind which it passes to the forearm; the musculo-spiral nerve winds behind the middle of the shaft of the humerus, between this and the triceps, X, to gain the outer side of the arm, while the median nerve crosses obliquely in front of the artery, to gain its inner side, and in this relative position both traverse the bend of the elbow, to enter the forearm, under cover of the superficial layer of muscles.

The branches of the brachial artery in the arm are numerous, but for the most part small in size. Little offsets are derived from it in its whole course to supply the adjacent parts. The two most considerable of its branches are the superior, 10, and the inferior profundus, 11. Of these, the superior is generally the larger; it is derived from the parent vessel, near the axilla, and having given off some of its subdivisions to the structures at the upper and inner side of the arm, follows in the course of the musculo-spiral nerve, and ends by anastomosing with the radial recurrent branch on the outer side of the elbow joint. The inferior profundus arises from the brachial, at the middle of the arm, gives branches to the inner side of the triceps, and passes, in company with the ulnar nerve, to the inner side of the elbow, where it anastomoses with a recurrent branch of the ulnar artery.

The brachial artery in its whole length has a close relation to the osseous axis of the limb, and allows, therefore, of being compressed in all situations against bone so effectually as to stop pulsation at the wrist. In the lower part of the arm where the vessel winds in front of the bone, compression is required to be made from before backwards. In the middle and upper parts of the arm, the vessel lying along the inner side of the humerus requires that compression be made from within outwards. In the axilla, it is possible to compress the artery against the head of the humerus, especially when this part is rotated downwards. The basilic vein lying in the course of the artery, in these three situations, will have its circulation at the same time arrested. In the neck, where the artery arches over the first rib to enter the posterior triangle, the vessel may be in some measure compressed against the bone, especially if the cleido-mastoid and scalenus muscles be relaxed.

Fig. 2. Fig. 1.



M & N Hanhart Imp.

Having examined the surgical relations of the principal bloodvessels in the neck, axilla, and arm respectively, we shall find on comparing those regions together, and viewing the main artery in its continuity, that we are best enabled to appreciate the facts which are of most significance in reference to deligation of that vessel. The proper site for a ligature, for whatever case required, is (according to general opinion) one allowing of the following requirements—the arrest of the direct circulation through the main artery above the part affected—the greatest possible freedom for the collateral currents through the anastomosing branches of the artery above and below the ligature and the disease—a secure hold for the ligature at a sound interval of the vessel, the longest between the roots of collateral branches,—and the exposure of the vessel at a situation the most accessible. Viewing the normal condition of the main artery as represented in Plate IX. Fig. 1, I shall remark first on the anatomical circumstances which may admit of the concurrence of all, or of the principal of those advantages, as well with the object of maintaining the life of the limb as with that of influencing the disease of the artery.

Between the sterno-clavicular junction and the bend of the elbow the main artery, I, exists as a single trunk, giving off branches to adjacent structures, and being itself destined for the supply of those more distant in the forearm and hand. This being the usual form of the artery, it will be seen that at whichever point we tie that vessel we cut off the direct circulation from the distal part of the limb, and leave this solely dependent for support upon the anastomotic branches. In respect to this particular, we find the arm to be less favourably circumstanced than the head as to the sources of vascular supply, for whereas the latter is served with many principal arteries, any one of which may be obstructed without very materially hindering the direct circulation through that part, the arm having but one main artery, the obstruction of this vessel renders the limb comparatively isolated. It being equal, therefore, as to the effect on the direct circulation whether the main artery of the upper limb be tied in the arm, in the axilla, or above the clavicle, our choice of a situation for performing that operation where the vessel is most accessible, and least beset with branches which may disturb the ligature, can at once be determined. In the arm the artery presents those advantages in a more marked degree than it does above the clavicle, and more so in the latter place than in the axilla. But as the safety of the limb is jeopardised not only by the aneurism but by the operation demanded for its cure, seeing that in obstructing the direct current of blood through the disease we obstruct it also in respect of every distal part of the limb, the consideration of chief moment now suggests itself, namely, at what situation may the ligature be applied to the main artery, with due effect on the disease, at the same time that the greatest amount of collateral circulation is maintained for the support of the limb. To decide this point, the form, number, and position of the anastomosing branches should be examined.

The branches derived from the main artery, between the sterno-clavicular junction and the bend of the elbow, I find to be, in regard to anastomosis, divisible into two classes, viz., that one in which, above the axillary folds, P, they anastomose in reference to the thorax and shoulder, and the other in which, below the axilla, they anastomose in reference to the arm. The largest branch arising from the artery is the sub-scapular, 9, and this terminates the thoracic series, 8, 7, 6, 5, &c. The largest of the brachial branches is the superior profundus, 10, and this commences the brachial series. Between those two classes of branches it will be observed that the points of anastomosis are but few in number and small in size—the most noticeable of them being those established around the shoulder-joint by the circumflex humeri and acromial branches, and the recurrent offsets of the superior profundus. Such being the anatomical condition at this particular part, we have from it a ready explanation why deligation of the principal artery here is less promising as to a favourable result than elsewhere; for the only channel of the direct circulation is obstructed where the anastomoses are fewest and in least force between the branches above and below the ligature. Considering, therefore, that the portion of the main artery intervening between the roots of the anastomosing branches is, as it were, the connecting bond between that half of it which belongs to the body and that which belongs to the limb, I believe it may be stated upon anatomical proof, as strong as mathematical, that the further upwards or downwards from this place we fix the seat of operation, the less we imperil the future safety of the limb. By tying the vessel at this part, we almost isolate the limb from the central circulating force; whereas, by tying it at some distance above or below the part, though certainly we arrest the principal current all the same, yet we leave in free action the largest amount of brachio-axillary collateral circulation. If, for example, the ligature be placed *above* one or more of the axillary branches, these, receiving the blood by anastomosis from others distributed over the thorax and scapula, contribute to maintain the circulation in the principal artery below the ligature; and if the ligature be placed *below* one or more of the brachial branches, these, as well as the axillary receiving the direct current of the main vessel in full force, are in a condition better fitted to communicate that force to such branches as they anastomose with, below the seat of obstruction. But in making these calculations on the condition of the main artery, in its normal state, it must be understood that however true they may thus far prove to be, yet they are liable to be more or less frustrated, not only by the existence of some anomalous condition of that vessel, but by the position of the disease or injury affecting it.

In the arm we not unfrequently find, instead of one principal artery, two or even three existing in its course. On examining at their source these supernumerary arteries, they are found to occur simply in consequence of a high division of the brachial artery. They are the arteries of the forearm which usually arise from the parent vessel, at the bend of the elbow. The varying characters of those vessels are those of number and place of origin. They are either two or three in number, according to the divisions of the principal artery, and they are all long or short, or severally of various lengths, according to the place where they arise. The main artery, as a general rule, divides less frequently in the upper than in the lower part of the arm; in the axilla it but very seldom divides, and as far up as the clavicle, never. The most frequent variety, as to number, is that in which two arteries appear, and of these the additional vessel is more often the radial. But of whatever kind those deviations from the normal condition happen to be, the following circumstances may be regarded as pretty certain. The plurality of arterial vessels seldom or never exceed three in number—they follow the usual course of the brachial artery—they hold a close parallel relation to each other, especially in the upper part of the limb—they supply the forearm in the same manner as the ordinary radial, ulnar and interosseous arteries—and they anastomose freely with each other in the hand. With these general facts in memory, we are prepared to meet (at least with an explanation) whatever inconvenience they may occasion in practice; and the cases in which such inconvenience may arise are fortunately but few in number. For an aneurism in the arm, or an aneurismal varix at the bend of the elbow, when it is required to tie the brachial artery above the disease, if on exposing an artery occupying the usual position of the brachial, we tie that vessel, and find, nevertheless, that the tumour is still strongly pulsatile, we infer, not only that two principal arteries must exist, but that either the aneurism is wholly sprung from the vessel untied, or else that this vessel directly communicates with the tied one above the place of the disease, or at the disease itself. In such an event it becomes necessary either to seek for and tie the additional artery at the present seat of operation, or to expose and tie the main artery above its point of division. As, however, it may not be possible to find the additional artery, and even if found, another may prove to exist, and as, moreover, it cannot be known for certain at what exact point the high division exists, we have

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FIGURES OF PLATE IX.

Figure I.

A. Sterno-mastoid muscle cut. — B. Anterior scalenus muscle. — C. Sterno-laryngeal muscles cut. — D. Clavicle. — E. Thyroid body. — F. Subclavius muscle. — G. Innominate artery. — H. Common carotid artery. — I*, I**, I***. Subclavian axillary and brachial artery. — 5. Thyroid axis. — 6. Posterior scapular. — 7. Thoracico-acromialis. — 8. Thoracicus longus. — 9. Subscapular. — 10. Superior profundus, and 11, inferior profundus branches. — KK. Brachial plexus of nerves. — 1. Median. — 2. Ulnar. — 3. Musculo-spiral, and 4, circumflex humeri nerves. — L. Internal jugular vein cut. — M. Subclavian vein cut. — M**. Basilic vein. — *m*. Cephalic vein. — NN*. Pectoralis major muscle cut. — O. Pectoralis minor muscle cut. — P. Latissimus dorsi muscle. — Q. Teres major muscle. — R. Lymphatic bodies. — S. Coracoid process. — T. Coracoid attachment of pectoralis minor muscle. — U. Coraco-brachialis muscle. — V. Deltoid muscle. — W. Inner condyle of humerus. — XX. Triceps muscle. — Y. Part of the sheath of the brachial artery. — ZZ. Biceps muscle.

Figure II.

All parts except the following are marked as in Figure I.

AA*. Axillary fascia.—*a a*. Sheath of the Vessels.—K. Median nerve.—MM. Axillary vein.—P. Subscapular artery.—T. Pectoralis minor muscle.—U. Coraco-brachialis; and Z, Biceps muscles covered by fascia.

but to return in this dilemma of doubt growing upon doubt to the one plain principle which no amount of anatomical experience in these matters can render more practically efficient, namely, to tie the bleeding ends of all arteries where wounded, and of that which is diseased at points as near as may be on both sides of the disease. Indeed, while acting upon this principle, and thereby assuring ourselves that we operate in direct reference to the diseased vessel, it appears to me that the individual in whom this plural condition of arteries in the arm exists, is more happily gifted than otherwise; for, while it requires the operator's care to choose a site for tying the normal single brachial artery, where anastomotic currents may be in freest force, this care is the less necessary where an additional principal artery is present, arising above the ligature, and passing free to the forearm and hand.

The seat of an aneurism determines the site for deligation of the vessel so affected, but does not render void the above-mentioned anatomical considerations, and by these it appears to me we should be chiefly guided in the treatment of the following cases—1st. For wounds of the forearm involving one or more of the arteries there situated, we should rather tie the several ends of the vessels in the wound than expose and tie the brachial artery, for by the latter proceeding we do more than is necessary for arresting the hemorrhage—we cut off all the direct sources of circulation through the forearm and hand, and leave these dependent upon the scarce anastomotic circulation around the elbow joint. 2nd. If the brachial artery itself be wounded the ligatures should be applied to that vessel in the wound. 3rd. If the brachial artery be affected with aneurismal varix at the bend of the elbow, the ligature should be placed on the vessel immediately above the tumour, with a view to its being below the two profundi branches, 10, 11, Figure 1, as the principal channels of collateral circulation. 4th. If the artery be aneurismal at the middle of the arm, the direct circulation through those branches becomes obstructed, and now, if the ligature be placed on the main artery at the folds of the axilla, below the subscapular branch, 9, the vascular connexion between the limb and the body will be reduced to almost the lowest degree of circulating force. To obviate this state, the best position of the ligature would be about the middle of the axilla, for here the branches above the ligature would maintain the collateral circulation by such anastomoses as may exist between them and the brachial branches, while those below the ligature, including the subscapular, would support a languid current through the main artery harmless, as I believe, though it be through the tumour also. 5th. When the axilla is the seat of aneurism, there will be, in most instances, no room for tying the artery between the disease and the clavicle; but even if there were, there cannot, I think, be any reason for our preferring this as the place of operation, when, with equal effect on the disease, and far less anatomical difficulty, the main vessel can be exposed and tied above the clavicle, and considering, moreover, that in the latter operation we remove the ligature further from the disease, and place it in a position midway between the cervical and axillary anastomosing branches. In making these remarks, it will be seen that little regard has been had to choosing a site for the ligature, where it might be less subjected to "disturbance" by the proximity of the origins of collateral branches, and this is owing to my reasons for believing that to other causes than this are failures in the operation much more justly attributable.*

Deligation of the axillary artery becomes necessary when that vessel is wounded. The course of the artery, I, Figure 2, in the axilla, would be indicated with sufficient accuracy in the living body by a line drawn from the middle of the clavicle, D, along the pectoro-deltoid interval to the inner border of the middle of the biceps muscle. In the interval named, the upper end of the cephalic vein, *m*, and some offsets of the thoracico-acromialis branch appear, and here also the coracoid process, S, may be felt, along the inner side of which the axillary artery passes. The incision usually recommended for exposing the axillary artery is one made parallel with the lower border of the clavicle, dividing the fibres of the pectoral muscle transversely, so as to allow of their retraction; but this incision, it will be seen, forms a right angle with the artery, and is hence less convenient than one made in the direction of that vessel. While the limb is abducted, if the incision be carried in the course of the artery and to the inner side of the pectoro-deltoid interval, the cephalic vein will be avoided, and the fibres of the pectoral muscles cut obliquely, which will be found all sufficient. On retracting the divided parts of the great pectoral muscle, N N, we expose the coracoid attachment of the lesser pectoral, T, and this having been next divided, and the cellular substance and fascia, *a a*, beneath it turned aside, the artery will appear closely embraced, especially in the lower part of the axilla, by the brachial plexus of nerves. This circumstance, together with the depth of the vessel, the number of branches derived from it, and the large size of the accompanying vein, M, which frequently overlies the artery, renders it a difficult task to pass the ligature around the latter vessel, with the care necessary for excluding the nerves and not injuring the vein.

Deligation of the brachial artery may, according to the nature of the case, be required at its upper, its middle, or its lower third. In the first situation the line of incision should coincide with the inner border of the coraco-brachialis muscle, U, Figure 1; in the two latter, with the border of the biceps, Z. The basilic vein, M, lying over the course of the artery, may be rendered turgid and apparent by pressing it above the situation where the artery is to be exposed; and now an incision of an inch and a half or two inches long having been made through the integuments, between the basilic vein and the biceps, and directed towards the osseous axis of the limb, the fascia, Y, forming the sheath of the artery, will, on retracting the cut parts, be seen. The artery, with the venæ comites and median nerve, K, being closely enveloped by the sheath, it will be safer to incise that membrane on a director; and, this being done, the contained structures come into view, having, according to the place of operation, the following different relative position—In the upper part of the arm, the artery having the median nerve close to its outer side; in the middle of the arm, having that nerve obliquely crossing over it, and in the lower part of the arm, having the nerve on its inner side. When the parts exist in this, their usual form, the artery can be reached with comparative facility, especially if, previously to the operation, we stretch and fix them, by extending the forearm; but occasionally difficulties will be found to arise from one or other of the following causes—the ulnar nerve, K 2, when the incision is made high up in the arm, is generally exposed, and will, if mistaken for the median nerve, K 1, make us err from the place of the artery—the median nerve may pass beneath the artery, and be concealed, or may be removed somewhat to the inner side of that vessel—the artery, either with or without the median nerve, may course apart from the border of the biceps, or one or both may be covered by a portion of the brachialis muscle. In the doubt attending those cases, the situation of the artery can only be safely ascertained by the pulsation of that vessel; and by this means, also, we are to inform ourselves whether there exist more principal arteries than one.

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* Amongst the various causes to which is ascribed the premature separation of the ligature from the artery, it appears to me that the principal is the very manner in which we apply the ligature itself. In this proceeding, as customarily accomplished, let us consider whether we do not already half effect that untoward result which we wish to avoid. *In exposing the artery too much we denude it of its proper nutrient vessels.* It is, moreover, that mere narrow ring of the vessel so denuded, with which the ligature is in contact, that is actually at first the only stay against disseverment and hæmorrhage; and what is the state to which we further reduce it? We draw the ligature so tight as completely to divide the two inner coats of the vessel and leave the continuity of the latter alone dependent upon the outer coat. Now the outer coat is itself, from the first moment after the knot is made, rendered extravascular and absolutely dead, owing to the contusing compression exercised by the ligature, and solely maintains the continuity by its physical properties. Those properties are, we know, under the circumstances, evanescent, lasting but a few hours, or at most a day or two—a period in which the adhesive process is scarcely begun, and this is about the time when secondary hæmorrhage usually occurs.

In the operation as thus performed the object is twofold—the temporary and the permanent arrest of the direct circulation; but it seems to me that in the means used for procuring the latter object we frustrate both. In order to arrest *temporarily* the direct current in any tube with yielding sides, it is only required to exert an amount of force sufficient to compress those sides in apposition. The momentum of the current is in the ratio of the caliber of the tube; and when that current is arrested by compression, its force is in the ratio of the area of the opposed surface,—is least at the point where the tube is constricted, and greatest at the sides of the tube which it tends now to dilate. A tied artery presents this condition, and therefore it is not only superfluous to draw the ligature closer than what serves for mere compression, but dangerous, inasmuch as it weakens the walls of the vessel at the critical point requiring to be preserved entire for a certain time. If, therefore, in these facts, there appear any reason to influence our mode of operating, the question as to the necessity of dividing the inner coats of the vessel may be answered in a very few words. We all know that a solution of continuity in any part is not necessary to induce the effusion of plastic matter. The inflammatory action consequent upon any cause of irritation is disposed to produce that matter, and surely the presence of a ligature is a sufficient cause to set up that action for this result.

Of the circumstances usually mentioned as tending to render the hold of the ligature insecure, the two principal are, a *diseased state of the vessel*, and a *close connexion to the roots of collateral branches.* Of the former of these I need only hint, that as it is both unnecessary to any purpose, and hazardous to the safety of the artery, to draw the ligature too tight when the vessel is sound, it must be more so when it is diseased. As to the danger incurred by placing the ligature near one or more branches, the very contrary would seem to be the actual state of the case, for while the retrograde circulation is at all times in minimum force, and cannot disturb the ligature, the branch above the ligature tends to diminish the dilating force on the main artery, by serving as a vent for the direct current, and hence the larger those branches are, and the greater their number, the better must that service be fulfilled.

PL. X.

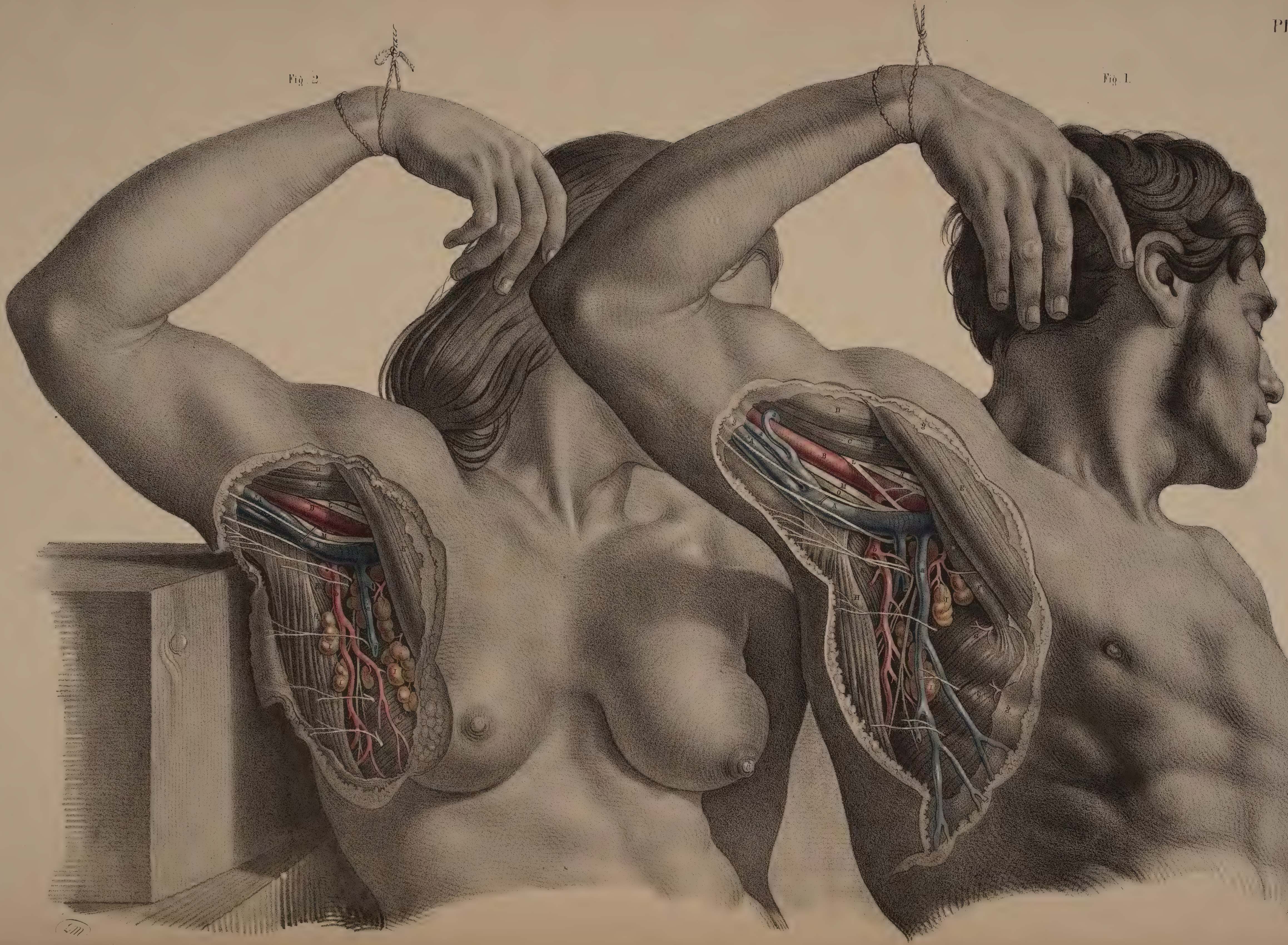

Fig. 2.

Fig. 1.

COMMENTARY ON PLATES X. & XI.

THE MALE AND FEMALE AXILLÆ COMPARED. EXCISION OF THE MAMMARY GLAND. MECHANISM OF THE SHOULDER APPARATUS. ANATOMICAL EFFECTS OF FRACTURES, DISLOCATIONS, AND TUMOURS.

The differential features which characterise corresponding regions in the sexes are for the most part superficial. When we submit those regions to anatomical comparison, we find them to be composed of parts similar, as well in relative position as in form and structure. These regions of the male and female being in this degree homologous, we are induced to inquire upon what circumstances the distinctions, such as they are, exist, and what is the signification of those distinctions. The sexual characters of form appear to depend solely upon the fact of the same organ being developed to a larger size in the one sex than in the other. The female mammary gland is a plus-fully developed organ, which, compared with the male mammilla, signifies that this latter is minus as to quantity—unevolved-rudimentary. This simple diversity of the greater and the less, which defines the sexual character of beings of the same species is indeed but a link in that chain of differential gradation which extends not only throughout the whole vertebrate animal series of classes, orders, genera, and species, but is further produced through all varieties of individual formation, abnormal as well as normal—the created and known, as well as the potential or possible and unknown. This generalization is as capable of demonstration as the fact, that out of the primitive circle all other geometrical figures may be fashioned.

The male and female axillæ, containing respectively the same number and kind of parts, we find that the difference manifested between the outward contours of both regions is owing principally to the enlarged mammary gland, which, in the female, overhangs and masks the pectoral muscle E, Figure 2, forming the anterior axillary fold. When we view the dissected axilla from below (the arm being raised from the side) it appears as a conical recess bounded laterally by the upper part of the arm and the thorax, and antero-posteriorly by the large muscles attached to the shoulder apparatus. As all operative measures in reference to the axilla are performed in this position of the arm, the relative position which the parts now assume should be well considered. The principal bloodvessels and nerves will be observed to traverse the axillary space in a closer relation to the arm externally than to the thorax internally. The thickness of the two pectoral muscles, E F, Figure 1, being very great, it will hence appear that the depth at which the artery, B, lies from the anterior surface must render it proportionately difficult for the operator to expose and tie that vessel at an incision made through them. On moving the arm, we move at the same time the vessels and nerves in the axilla, and we notice the extent to which we can influence their relative position when necessary. Placing the arm close to the side, we contract the axillary space, and bring the vessels in apposition with the thorax, when they will be seen to form a general curve from the episternal region to the limb, the concavity of that curve being turned to the thoracic side. But on abducting the arm, and elevating the shoulder, the vessels and nerves assume a serpentine course, the first bend of which between the clavicle and head of the humerus is convex in respect to the thorax, and the second that bend which the head of the humerus projecting downwards forces them to make between it and the inner side of the arm. It is when the head of the humerus is rotated downwards that we are enabled to arrest the circulation in the artery by compressing it with the thumb against that bone. While the arm is raised, we observe the fascia which closes the humeral outlet of the axilla is on the stretch between the pectoral and latissimus dorsi muscles, and also that in this position the vein, A, becomes more closely applied to the artery, concealing the latter and the principal nerves, L M N O, of the brachial plexus.

The lymphatic bodies, I, which we find in the axilla, are numerous and of various size. They are generally more numerous in the female than in the male. The greater part of them are situated under the axillary borders of the pectoral muscles, and others of them are in contact with the main vessels; the former being supplied by the thoracic arteries, the latter by offsets derived directly from the axillary artery itself. Those bodies, when affected with scirrhus, form large nodulated masses, occupying in some advanced cases of the disease the whole axillary space, causing the shoulder to be permanently elevated to make room for them, and even then acting as a serious impediment to the circulation through the vessels, and to the free motions of the shoulder joint. The axillary and cervical lymphatic bodies forming a chain in the course of the vessels will generally be found diseased at the same time.

The contractile motions of the pectoral muscle of the male are distinguishable beneath the integuments, and the manner in which it determines the form of the pectoral region, and bounds the axilla anteriorly, is in this sex well defined. In the female, on the contrary, we observe that though the pectoral muscle has the same relative position as in the male, the external form of the pectoral region depends principally upon the existence of the enlarged mammary gland and the adipose tissue, in which this organ is embedded. The female breast, consisting of the integuments, adipose tissue, and glandular body, varies in size and form in different individuals; but the difference in these respects is not so much owing to the variable dimensions of the true glandular part as to the variable quantity of the cellular-adipose substance surrounding this organ. The gland itself is of a shape nearly hemispherical—convex in front and flattened behind. It is enveloped in a firm capsule of condensed cellular membrane, which binds its lobes and lobules together into one mass isolated from neighbouring parts. All the lactiferous ducts issuing from the lobules concentre towards the middle of the gland, and at this place uniting into common ducts of larger size and fewer number, they form conical dilatations, and enter the nipple which projects from the cutaneous surface. The terminal ducts open at the summit of the nipple by separate orifices, varying from six to a dozen or more in number, while others are directed to, and often open on, the tubercles of the areola, which are likewise lactiferous, not sebaceous. These indicate to me that the organ is to be classed with the tegumentary glands in general, but particularly with the sudoriferous glands, of which, in fact, the mamma is a modification representing an aggregate of those glands bound together, severally enlarged, but still anatomically similar to them in structure, though physiologically differing from them in function—in the quality of the excreted fluid.

The mammary gland is retained in its position chiefly by the skin, which forms a pouch for it. In childhood, when the organ is rudimentary, the pouch does not appear, and the sexes in this particular are then undistinguishable. The gland, on becoming developed towards puberty, forms for itself that receptacle, characteristic of the female; while in the male the primitive form remains. In the virgin state of the gland, its base is applied closely to the fascia covering the pectoral muscle, but the connecting medium between the two, consisting merely of lax bands of cellular membrane, yields in the maternal state with the increasing weight of the organ, and allows this to fall apart from the side of the chest over the anterior axillary fold. The gland having assumed this pendent position, is then uninfluenced by the motions of the muscles beneath it; but when it is the seat of scirrhus, it becomes bound to the pectoral

FIGURES OF PLATE X.

Figure I.

AA*, *aa*. Axillary vein and tributary branches. — B. Axillary artery. — *b*. Its subscapular branch. — C. Coraco-brachialis muscle. — D. Biceps muscle. — E. Pectoralis major muscle. — F. Pectoralis minor muscle. — G. Serratus magnus muscle. — *g*. Fascia. H. Latissimus dorsi muscle. — I I. Lymphatic bodies. — K. Subscapular muscle. — L. Median nerve. — M. Ulnar nerve. — N. Musculo-cutaneous nerve. — O. Musculo-spiral nerve.

Figure II.

All parts are marked as in Figure I.

muscle by that disease, and is thereby rendered comparatively fixed. In this state the nipple becomes depressed, owing to the tumefaction of the surrounding tissues, and particularly also to the fact, that the disease retracts the part by means of the lactiferous ducts, which serve as bridles between the two. As the male breast is mammiform, having a glandular apparatus similar to that of the female in all respects save in size, so is it observed occasionally manifesting a physiological function, in imitation of the female organ; and it is in both sexes subject to similar diseased conditions. In the male, as in the female, we find the gland to be the seat of scirrhus, but its occurrence in the latter is much more frequent, as might be expected from the circumstance of the greater structural and functional perfection of the organ in this sex.

The bloodvessels and nerves of the mammary glands being small in size, are not particularly named. The internal mammary artery has no more direct relation to the gland than other neighbouring vessels. The small terminal branches of this artery, those of the upper intercostal and those of the axillary thoracic arteries, supply the part scantily at all times, save that of lactation. When this process commences in the latter months of pregnancy, those vessels enlarging take on an increased action, and their accompanying veins also become then enlarged. In this periodical vascular excitement the mammæ express the state of the uterine organs, manifesting a similar phenomenon, the former preparing to assume the office of the latter in respect to the future support of the offspring. The nerves of the mammary gland are derived from the cervical plexus, the intercostal and the axillary nerves. Those nerves are of the common sensory cutaneous class.* The lymphatic vessels of the mammæ enter the axillary space, where they form the chain of lymphatic bodies under the pectoral muscles, and thence following the main bloodvessels, join with those of the posterior triangular space in the neck.

The breast varies in form, and with those variations it is very necessary to be well acquainted, in order that we may distinguish clearly between the natural and diseased conditions of the part, as well as between those diseases which have a more or less evil tendency. Besides those differences in form and size, which naturally appear before, at, and after puberty, and those which are owing to the greater or lesser obesity of the individual at those several periods, it is stated that the two breasts of the same female generally vary in size, the left being greater than the right. The nipples, too, are more prominent in some than in others; and instances present themselves in which those parts scarcely project beyond the cutaneous surface. According as the subcutaneous adipose tissue is removed, the true glandular part becomes distinguishable through the skin, as having an uneven surface. This inequality appears the more marked, when in cases of emaciation the adipose substance is also absorbed from the alveoli or interlobular spaces. In this state, if the fibrous capsule of the organ be thicker than usual, the lobules which that membrane incloses and isolates from each other by septa present a dense nodulated appearance. In cases of extreme hypertrophy of the fibrous structure, the true glandular part atrophies, and the breast having degenerated into an innocuous fibrous tumour (lipoma,) is liable to be mistaken, as being attacked with malignant disease. In aged females, who have borne many children, the unevenness of the surface of the organ is generally very apparent; the fibrous thickening is also a natural condition, and in these likewise the edge of the organ, never being perfectly smooth, uniform, and circular, frequently exhibits distinct, irregular, rather solid prolongations of variable size and number, which, though normal and therefore harmless, may seem to some the result of diseased action. The gland, which is in some females hemispherical, is in others elliptical, having its long axis extending upwards and outwards in the direction of the shoulder, and sometimes not only overhanging the axillary border of the pectoral muscle, but is in structural apposition with the upper part of the serratus magnus muscle, and mingling with the lymphatic bodies in this situation. Like the fibrous and glandular tissues of the breast, the interlobular adipose parts are liable to simple hypertrophy, causing an uniform enlargement of the breast, when all those parts are increased, or isolated fatty tumours, when only one or two of them are in this state. In the former condition, operative measures are of course inadmissible; in the latter, only required for removing the deformity, and lest from the excessive increase of such tumour, the true glandular structure become atrophied by pressure. A large breast is not always indicative of a large glandular organ, nor does the latter always betoken a large secreting organ, for the breast may be more fatty than otherwise, and more fibrous than lobular. Between the gland and the pectoral muscle the adipose tissue does not exist, and hence fatty tumours seldom appear in this situation. The breasts of the same female, though usually of the same form, and developed symmetrically in respect to the body, are not invariably in this condition, and yet their dissimilarity is not to be attributed to what we understand as diseased action. The causes above mentioned of the deformity apparent between the breasts of different individuals may exist in those of the same person. The number of the glandular lobes of the left breast and the number of its ducts also may be less or more than those of the right breast; and, naturally, the two glands in these respects are varied nearly always. With these facts borne in mind, we are best enabled not only to distinguish the diseased states, but to judge aright when a cutting operation may be absolutely necessary and when not.

The breast is very subject to acute inflammation, and especially at the period of lactation, which proves that it is in the glandular part the inflammation originates, and also that this is but an excess of the natural vascular excitement capable of being avoided, and, when not carried beyond a certain stage, of being subdued by the timely process of suckling. This inflammation often induces suppuration when not checked, and gives rise to one or more abscesses in different situations circumscribed and isolated by the fibrous envelopes of the lobules, or between them in the alveoli. Those abscesses may also form in the ducts behind the nipple, or on the surface of the gland in the fatty tissue, or beneath the gland in the loose cellular tissue, connecting the part with the pectoral muscle. In the latter situation, it is difficult to detect the abscess until it has advanced to a great size; and then when it is voided by incision, the cavity between the gland and the chest is so large as to render adhesion difficult to produce, and a recurrence of the purulent deposit inevitable. When, as in chronic abscess, the matter is deposited in one of the fibrous envelopes of a lobule and distends it, it simulates a solid tumour; and this explains why the former case is so often mistaken for the latter, and not ascertained till during a cutting operation. The situation where an abscess points through the integument, is that at which the puncture should be made; but in deep-seated abscess, when the place of puncture is in some degree at the choice of the operator, the surgical anatomist will avoid (as well as he may) opening the part near the nipple, behind which the lactiferous ducts congregate, and if it be necessary to make the opening here, he will carry it in the direction of those ducts, so as to divide the fewest number of them possible. A dependent opening permits more readily a free continuous discharge. During lactation, when the vessels are enlarged, and the vascular-supply greater than at other periods, incisions in the breast may occasion considerable hemorrhage; and as the gland has now assumed its secreting function, a wound of two or more of its principal ducts made in opening an abscess may give rise to *lacteal* fistula, either directly through the skin, or indirectly through the cavity of the abscess.

The mammary gland being composed of many parts, for the disease of one part, when requiring excision, we should not sacrifice the whole organ nor any more of it than is absolutely necessary. When any portion of the gland is healthy, and fit to be left, of course, in order to render it still functional, the nipple should also be saved. In non-malignant growths, such as the adipose and the small round moveable tumours, which prove to be only indurated lymphatic bodies, situated in the substance or on the surface of the gland, that organ may, in most instances, be left intact compatible with their complete removal. This remark applies also to the malignant growths in their early stages, when they stand *per se*, not involving other structures. As at first it is not

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* The anatomical signification which I give to the *mammary gland as an aggregate of enlarged sudoriferous glands* appears to be borne out by all particulars. The vessels supply both in the same form, and the nerves of both are of the same kind. The ducts of both open by distinct orifices on the cutaneous surface. In the nipple, the ducts and orifices, though clustered, are still distinct, and here *lactiferous.* In the neighbouring integument they are regularly spread, and are here *sudoriferous.* The *tubercles of the areola* mark the *graduated transition between the sudoriferous and lactiferous glands.* The tubercles are *lactiferous,* and they appear occasionally, even in the human female, so large as to simulate the nipple itself. In the same species of animals, especially the Ruminants, I have noticed the number of nipples on the same dug to vary. In all animals of different classes the nipples vary normally as to number. In the human species even three or more separate mammæ with distinct nipples have been observed. In various species of animals the mammæ vary not only as to number, but as to place. In the *elephant,* for example, they are *pectoral,* and *two* in number; in the *cow* they are *pelvic* and *single by the union of two;* in the *bitch they range in double rows, of six or eight in each, between the breast and the pubic symphisis.* With these facts in view it will be noticed how, while all other organs of the animal body, whatever be their size and the degree of their metamorphosis, still exhibit the uniformity of the law of nature as to number and relative position, we find the diversity of species marked as to the two latter particulars solely by the mammæ. The rationale of this will be seen in the analogy I have drawn; for as the sudoriferous glands are universally distributed, so is it *potential* in nature for them to be, by a simple increase, metamorphosed to mammiform organs, in any situation and of any number, till the animal, like the Tellus of Polytheism, stands forth all paps. As it is, we find the number and the place of the organs in each species to accord with the number and character of the offspring—the fitness alone limiting the operation of the law of development and change.

Fig. 1.

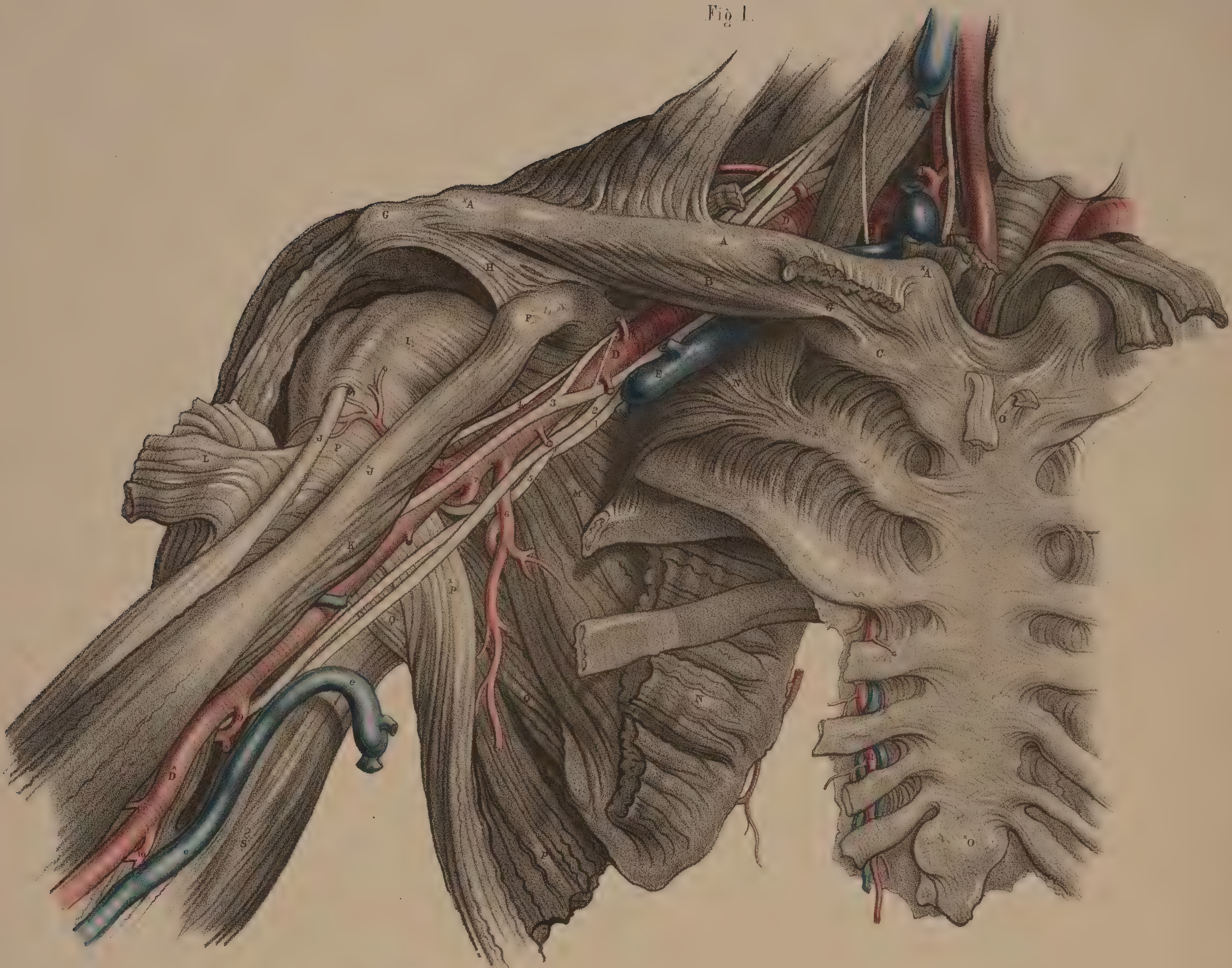

Fig. 2.

possible to distinguish between the two classes of tumours by any character of pain or physical sign, the doubt must still arise whether we should avoid an operation as unnecessary, or perform it as a precautionary measure against future ill consequence, or defer it till the disease manifests the usual symptoms said to be diagnostic of its malignant nature. Those symptoms which should characterize the tumour as malignant are, however, not themselves very clear. Any kind of pain may be called "lancinating," at the will of the patient; any tumour may cause retraction of the nipple, and any irritation of, or abscess in, the breast, may produce enlargement of the axillary lymphatic bodies. In slowly growing tumours, which thereby mark their benign nature, the lymphatic bodies are said never to enlarge, and this may be true, but the same is true also of the malignant tumours in the early stages of their growth.

When it is required to excise the mammary gland from the male or female breast, that operation (if the disease be confined to the structure of the gland or to the parts in its immediate vicinity) may be performed in full confidence that no important vessels or nerves will be found crossing the line of section, however made. But when the axillary lymphatic bodies partake of the same disease as that found in the gland, they also requiring to be removed, will render the operation proportionately more difficult, according to their proximity to the main vessels and nerves of the axilla. The shape of the external incision must be determined according to the shape of the tumour and the degree in which it involves the skin. It is to be made parallel with the fibres of the pectoral muscle when extended. For a simple fibrous or fatty tumour a linear incision will be found sufficient, as it allows of being widened, owing to the free pendent form of the breast. If the tumour be a scirrhus of some standing, its radices branching through the entire gland, and contracting adhesions, perhaps, with the skin and the pectoral muscle also, the incision will require to be made double, so as to isolate an oval portion of the skin, in order to effect the entire removal of the diseased structures. In this operation for excising a malignant tumour, the rule prescribed is that one "cannot err in taking away too much," but there is a middle course to be followed even here. When the axillary lymphatic bodies are likewise scirrhous, they must be extirpated, and, in doing so, due regard is to be had to the relative position of the main vessels and nerves. In dissecting the diseased parts from the axilla, the arm should be abducted as widely as possible, for the vessels become thereby withdrawn to the fullest extent from the seat of operation.

The axilla becomes very frequently the seat of morbid growths, which, when they happen to be beneath the dense fascia, and have attained a large size, press upon the vessels and nerves, and produce very serious results. Besides aneurisms and enlargements of the lymphatic bodies, we find adipose and other kinds of tumours occurring here, which, being prevented protruding externally by the fascia and muscles, press against the axillary vein, so as to cause œdema of the upper limb, and against the artery, obstructing it to such a degree that the collateral circulation has to be set up for the support of the member. The desired effect of pressure on the main artery for the cure of an aneurism of it is, in such cases, plainly illustrated and suggested to us for imitation by the hand of nature herself; and from her indication we should take another idea, of no less practical utility in its own line—namely, the necessity for fashioning of a proper form, size, and consistence, all apparatus which, in fracture or dislocation of the shoulder bones, are required to support those parts, lest we cause such impediment to circulation and innervation as must render our curative measure even worse than useless.

When abscesses occur in the axilla beneath the fascia, this structure will hinder the matter from pointing externally, and, in the meantime, the loose cellular tissue becoming disorganized and broken up, the fluid is allowed to burrow fistulous passages through the intermuscular spaces. The original seat of such abscesses is generally one or other of the lymphatic bodies, so prone to inflame and suppurate on any cause of irritation, especially in the scrofulous diathesis. The lymphatic body is, in some cases, external to the fascia, and the matter then gains a ready outlet; but when situated under the fascia, this membrane requires to be divided, and, in doing so, due regard should be had to the position of the main vessels. The limb should be abducted or raised as much as possible, so as to render the fascia tense; and as the vessels take the direction of the humerus, the point of the scalpel should penetrate in the opposite way—towards the side of the thorax.

The relative anatomy of the several parts (bones, ligaments, muscles, &c., comprising the shoulder apparatus) forms a study of very great practical importance. This apparatus, Plate XI., Figures 1 and 2, constructed for the free action of the scapulo-humeral joint, which is the most moveable of all others, is necessarily surrounded by numerous and powerful muscles; and it is found, on every experience, that those muscles, so suitable for moving the bones when entire, become the principal obstacles to readjustment when the bones are fractured or dislocated. The axilla is always concerned in these accidents. It becomes distorted on their occurrence, and the important parts contained in it are more or less injured, displaced, or obstructed. It is here, moreover, that the relative position of the disunited bones may, in most instances, be readily detected by the touch.

The osseous fabric of the shoulder apparatus consists of the scapula and clavicle, so connected with the upper part of the thorax, as to allow them to move freely in all directions, to facilitate the motion of the upper limb as a prehensile organ. The scapula, O O*, Figure 2, is laid flat upon the back of the thorax, to which it is connected only by muscles, N M P. The breadth of the bone fulfils two principal purposes—viz., to afford leverage attachment to those muscles, and a large surface for gliding motion and for steadiness. The muscles connected to the scapula perform the office of ligaments, but as motor powers they serve a purpose which ligaments could not supply. The clavicle A A, Figure 1, is placed in front of the thorax, to the top of the central sternal bone of which it is articulated, and bound by ligaments. The cylindrical form of the clavicle is in accordance with its uses; it is the lever of motion directly acted upon by its own muscles, and indirectly by those of the scapula, while the first sternal piece, O, is the sustaining fulcrum of both bones. The clavicle and scapula are connected together at the shoulder by ligaments, A G H, as well as by muscles, and hence it is that one bone cannot be moved without the other. The two bones are joined at an angle, the apex of which is at the shoulder, and the base of which spans the thorax antero-posteriorly. The anterior side of this angle, formed by the clavicle, being the only part which abuts articularly against the thorax, explains why the clavicle, notwithstanding its adaptation to its office, so much more frequently suffers fracture than the scapula, which is free in its position, and yields to impelling force from the shoulder. This mechanism, so fitting for the required action of the upper limb, can also be demonstrated geometrically to be, under the circumstances, the best calculated for preventing fracture and dislocation. The sterno-clavicular articulation permits of motion, within certain limits, in all directions; and the scapula, unconfined except by muscles, is allowed, by the relaxation of some of these, to obey those motions, while, by the contraction of other muscles, it promotes them. The thorax, received into the scapulo-clavicular open angle, tends, like a wedge, to sunder the sides of the latter when force is applied at the shoulder, but the scapula being free, and allowing of a yielding motion, facilitated and yet governed by the acromio-clavicular articulation, the force which otherwise might fracture the apparatus is, in a great measure, distributed through all its parts.

The clavicle, A, and the acromion process of the scapula, G, projecting laterally from the small upper end of the thorax, are joined together and form the shoulder. In the interval between the shoulder and the thorax, the principal vessels, D E, and nerves, 1 2 3 4 5, have free space to pass to the arm, and suffer no degree of compression under any motion of the

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FIGURES OF PLATE XI.

Figure I.

AA*. Clavicle. — B. Subclavius muscle.—C. First rib. — DD*. Axillary and brachial artery and its branches. — 6. Subscapular. — 7. Posterior circumflex. — 8. Anterior circumflex. — 9. Superior profundus. — 10. Inferior profundus. — 11. Internal mammary.— E *e*. Axillary and basilic vein cut. — F. Coracoid process. — G. Acromion process. — H. Coraco-acromial ligament. — I. Head of the humerus in its capsular ligament. — JJ*.. Long and short tendons of biceps muscle. — K. Coraco-brachialis muscle. — L. Tendon of pectoralis major muscle cut. — M. Subscapular muscle. — NN. Serratus magnus muscle cut. — OO*. Sternum. — P. Latissimus dorsi muscle cut. — Q. Teres major muscle. — R. Deltoid muscle. — S. Triceps muscle.

Figure II.

All parts except the following are marked as in Figure I.

B. Omo-hyoid muscle. — D. Subclavian artery, and suprascapular artery. — E. Brachial plexus of nerves. — F. Spine of scapula. — H. Coraco-clavicular ligament. — J. Supraspinatus muscle.—K. Teres minor muscle cut. — L. Infra spinatus muscle cut. — M. Rhomboid muscles. — N. Levator anguli scapulæ muscle. — OO. Scapula.

parts. The projection of the shoulder serves also another use—that of bearing the scapulo-humeral joint free of the side—a position necessary to its function. In addition to the acromio-clavicular junction, the coracoid process of the scapula, F, Figure 1, is connected by strong ligaments, H, to the outer end of the clavicle. The humerus is articulated with the scapula only; and hence it is that the shocks and motions of the former do not influence the clavicle, except through the scapula, which is the more yielding of the two shoulder-bones. The articular head of the humerus is a hemisphere, while the articular facet of the scapula, of much smaller proportions than it, represents a vertical ellipsis slightly hollowed to receive it. Between the margin of the articular surface of the scapula and the neck of the humerus, a strong capsule, O I, Figure 2, exists; but this is so ample and loose as to serve but little in keeping the two bones applied to each other; in fact, when the muscles are removed, the humerus, suspended by the capsular ligament alone, hangs from the scapula in a state of semi-dislocation. To this anatomical circumstance, it is usual to ascribe the comparative frequency of dislocations of the scapular end of the humerus, and especially that into the axilla; but let us here examine the beautiful contrivance which prevents those accidents being more frequent than they are. It is a law in physics that all joints constructed to perform *circumduction* enjoy this freedom of motion at the expense of insecurity. The shoulder joint is constructed for this kind of motion in a wider range than any other joint in the body, and hence might appear its greater liability to luxation. The glenoid articular facet of the scapula is necessarily shallow, and of smaller diameter than the hemispherical face of the humerus, so as to allow the latter to move in circumduction; and in every motion of this kind the bones tend to disarticulation. But in animal mechanics, we observe that when the safety of parts is thus sacrificed in some degree for the gain of motion of one kind, the structural weakness is in an equal degree fortified by a compensative motion of another kind; for it is true that in none of the *natural* positions of the limbs can displacement occur. The scapula not being articulated with, but gliding freely on, the thorax, is thereby allowed to oppose its articular face to that of the humerus freely in all directions, and the axes of those parts of both bones thus coinciding, the face of the scapula, though small, meets that of the humerus with no less security to both, than if the joint were a cup and ball; and at the same time with nearly all the range of motion of a joint of the *universal* kind.

In recognising to what extent the shoulder bones are moveable on the trunk, we can estimate correctly the amount of motion which the scapulo-humeral joint is capable of performing. When the scapula is fixed and the arm moved in circumduction, the latter describes a cone of which the base is at the hand, and the apex at the shoulder-joint. This range of motion is really little more extensive than that of the hip-joint. But when the scapula is free, the arm moved in circumduction can describe a circle, the periphery of which is marked by the hand, the centre by the shoulder-joint, and the radii by the limb. This difference between the motion of the upper and lower limbs is ascribable solely to the mobility of the scapula in the one case, and the fixity of the hip-bone in the other; for on examining both joints in their recent state, we find that their anatomical dissimilarity is far less than what we might infer from the denuded osseous parts of each. The glenoid facet of the scapula is not the only part of that bone with which the humerus articulates. The acromion and coracoid processes, with the strong fibrous band between them, constitute an essential part of the joint projecting over the glenoid face, forming with this a deep receptacle for the head of the humerus, guarding the joint and serving as an advantageous point of attachment for the deltoid muscle. Between the coraco-acromion arch and the head of the humerus we find a large bursa, which is embedded in loose fatty tissue and communicates with the interior of the capsular ligament. This bursa is a part of the capsule, and its use is to obviate the effects of friction which the tuberosities of the humerus exercise against the coraco-acromial arch in all its motions. To the existence of that arch is due the fact that dislocation of the head of the humerus cannot occur in any of the upward directions, and though we experience the frequency of that accident in the downward direction, it must be confessed that this is owing more to the overstrain of the parts against which no joint is secure than to any anatomical defect. When the arm is being abducted to the full extent, the tuberosities of the humerus pressing against the coraco-acromial arch communicate that motion to the scapula, while this bone rolling on the thorax by means of the acromial-clavicular joint yields to that force, which otherwise would tend to displace the head of the humerus into the axilla. But when that yielding of the scapula is carried to the natural limit, and the limb further strained in abduction, then the coraco-acromial arch acts as a fulcrum for the neck of the humerus, and actually facilitates, rather than prevents, the accident.

The muscles connecting the shoulder bones with the trunk and those connecting the humerus with the shoulder bones second each other in action. Circumduction is a combination of all the motions performed by those muscles in respect to the limb as a whole. Furthermore, the muscles are so arranged in respect to the bones and to each other, that according to the position of the limb, they perform various actions; as, for example, those which serve to rotate the arm when adducted, forcibly adduct it when abducted. It would seem to be owing solely to the tonic contraction of the muscles that the head of the humerus is kept closely applied to the glenoid face of the scapula, if one were to judge from the loose capsular ligament as seen in the dead subject. During life, however, the capsule, notwithstanding its looseness, yet contributes to the effect upon a principle of its own. The capsule forms a shut sac. Its inner surface is lined by the membrane which furnishes the synovial fluid. In the dissected state it presents as a bag having an interior or enclosed space; and the two bones which it connects fall apart from each other, but in the living state no such cavity exists. The capsular sac is during life completely collapsed, and while the folds into which it is thrown around the joint admit of the necessary free extension in the various motions of the head of the humerus, yet this bone never leaves the glenoid facet, to which it is applied as closely as by suction. In fact, not only this, but every other joint when whole, as in life, is a pneumatic apparatus, the two bones adhering together on the same principle as the bell-glass of an air-pump adheres to the floor or table of that machine.

When the head of the humerus is displaced completely into the axilla, the capsular ligament is always torn in that direction, and is dragged tensely across the glenoid face of the scapula. In this accident the infra spinatus, L, Fig. 2, and teres minor muscle, K, are either stretched or torn, while the supra spinatus, J, is generally torn. The subscapular muscle, M, Fig. 2, is rent somewhat from the venter of the bone; and the circumflex humeri vessels, 8, 7, and nerve, 5, are generally more or less injured, occasioning paralysis of the deltoid muscle and extravasation of blood around the joint. At first the limb is lengthened and somewhat abducted, owing to the low position of the head of the humerus; but after a time this being drawn upwards by the contraction of the coraco-brachialis and biceps, K, J, Fig. 1, and deltoid muscle, R, either under or over the subscapularis, and forcing out of their proper position the axillary vessels and nerves, the limb becomes shortened and abduction is less marked. The pressure on the main vessels now impedes the circulation of the limb, and œdematous tumefaction is the consequence; while the pressure on the brachial plexus causes much pain, and occasionally paralysis of the limb, either partial or complete. In fractures of the humerus, either at its neck or below its tuberosities, the displacement of the parts is chiefly owing to the action of the muscles inserted into either fragment, but is seldom such as to obstruct the main vessels or injure the brachial plexus.

The clavicle, A, Figure 1, forming an arch for the main vessels, D E, passing between it and the side of the thorax, it always happens when the bone is fractured at its middle that they and the accompanying nerves suffer pressure. This will occur whatever relative position the fragments assume from the action of the muscles inserted into them. If the two fragments lie end to end, the pectoralis major, subclavius, B, and deltoid, R, cause the arch to sink over the vessels, for those muscles have a united power in this respect greater than that of the cleido-mastoid and trapezius inserted into the inner and outer parts of the upper surface of the bone. When the fragments are displaced, the one riding over the other, the natural width of the sterno-acromial measurement is lessened, and that part of the bone which is the lower of the two presses upon the vessels. The clavicle is generally fractured at its middle when the accident is occasioned by falls on the shoulder; for the axes of the outer and inner halves of the bone do not correspond—that of the former being behind that of the latter. The weight of the limb and the attachment of the deltoid muscle cause the outer part of the clavicle when fractured generally to sink below the level of the inner part. The relative position assumed by the fractured parts of the clavicle depends, however, as much upon the point where the injury happens as upon the muscles attached; but the subclavius becomes, by reason of its position, in all cases a principal agent in frustrating our endeavours to effect a complete adjustment of the fracture, at the same time that it defends the vessels beneath it from being lacerated. Dislocations of the sternal end of the clavicle are unfrequent, and the backward variety more so than the forward one, because of the greater strength of the posterior than the anterior ligaments. In the displacement backwards the trachea and carotid arteries would be subjected to pressure. When the acromion process is fractured and depressed, the deltoid loses the power of abducting the arm, almost as much as if the muscle were paralyzed; for it is by the projection of the process over the head of the humerus that the muscle is effective in giving that motion.

Fig. 2.

Fig. 1.

M. & N. Hanhart imp.

COMMENTARY ON PLATES XII. & XIII.

THE SURGICAL DISSECTION OF THE BEND OF THE ELBOW AND THE FOREARM, THE WRIST, AND THE HAND. VENESECTION. AMPUTATION. DELIGATION OF THE RADIAL AND ULNAR ARTERIES, &c.

The farther a surgical region happens to be removed from the centre of the body, the less likely is it that accidents or operations which involve such regions will affect the life immediately. The limbs undergo all kinds of mutilation, both by accident and intention, and yet the patient survives; but when the like happens at any region of the trunk of the body, life will be directly and seriously threatened. It seems, therefore, that in the same degree as the living principle diverges from the body's centre into the outstanding members, in that degree is life weakened in intensity: and just as, according to physical laws, the ray of light becomes less and less intense by the square of the distance from the central source, so the vital ray, or *vis*, loses momentum in the same ratio as it diverges from the common central line to the periphery. But in the hand those scattered rays again concentrate, and in their focal strength that special outpost of the mind, the sense of touch, is manifested. Hence, a member of such great importance as the hand necessarily claims a high interest in surgical anatomy. The hand is typical of the mind; it is the material symbol of the immaterial spirit; it is the prime agent of the will, and is that instrument by which the human intellect manifests its power in creation. The human hand has a language of its own. While the tongue discourses of the thought by the word, the hand renders visible and demonstrates the thought by the work. This organ, therefore, whose fitness of form serves the mind for declaring its own entity in nature—which serves for realizing the invention, that is, as it were, the mind's autograph, demands that we stay the ruthless scalpel, that we pause and be "conservative" in our operative surgery. On this score it is laid down as a rule strictly to be observed, that when this beautiful and valuable member happens to be mutilated, in any of those various accidents to which it is exposed, our first consideration should be, not as to how many of its parts we can dexterously deprive it of by operation, but as to how many we can contrive to spare, since no mechanical ingenuity can fashion an apparatus capable of supplying the loss of a finger, or even of one of its joints.

The relative anatomy of the bend of the elbow is of much surgical importance, owing to this part giving passage to the principal vessels and nerve of the limb, owing to its being the usual situation for venesection, and the seat of accidents happening to the main artery in the awkward performance of that operation. When we have removed the integuments from the forepart of the arm and forearm, Figure 1, Plate XII., we find numerous veins and small nerves passing in various directions over the surface of the fascia. The veins congregating from the front, sides, and back of the forearm and hand, at first of small size, may be seen to become, by an union of two or more of them, larger in size and fewer in number as they approach the bend of the elbow. In this place they form two principal veins, the basilic, B, and the cephalic, D, between which is a communicating branch—the median basilic, E, of the same caliber as theirs, and from which another branch, F, arises and soon sinks beneath the fascia on the outer side of the biceps tendon, *a*, to join the deep set of veins. The cephalic vein, formed principally of those which course upwards on the outer border of the forearm, ascends the arm externally along the groove between the brachialis anticus and the biceps muscle. Here the external cutaneous nerve first appears superficial to the fascia, and passing in the course of the cephalic vein, branches among the tributaries of that vessel subcutaneously as far down as the wrist. The basilic vein, commencing by numerous small vessels, arriving from the inner side, front, and back of the forearm, and receiving the median basilic, passes up the arm internally along the groove between the biceps and brachialis muscle, superficial to the fascia; and having lying on it the internal cutaneous nerve, which in descending divides above the level of the inner condyle into three or more branches, to be distributed to the integuments of the front, inner, and back parts of the forearm. Numerous other cutaneous nerves, issuing from the axilla, are to be found in the course of the basilic vein. The nerves of both sides, like the veins, form frequent communications across the forearm; and some of the veins have the nerves lying on them.

The fascia of the arm, A, Figure 1, is continued over the forearm, H; and in both situations forms a sheath for each of the muscles. At the bend of the elbow may be noticed a fibrous band given off from the inner border of the biceps tendon to blend with the fascia, which covers the origin of the muscles arising from the inner condyle. The median basilic vein, E, rests upon this band; and the brachial artery, G, with its venæ comites, and the median nerve, D, Figure 2, pass beneath it. On removing the fascia and superficial veins, Figure 2, we bring in view the brachial artery and median nerve, with the muscles. The basilic vein will be noticed passing upwards in the course of the artery, the fascia alone intervening between the two, and forming a sheath for the latter vessel and the median nerve. The venæ comites, on either side of the artery, communicate by cross branches. In approaching the bend of the elbow the median nerve appears at a little distance to the inner side of the artery, owing to this vessel bending from it outwards along the inner border of the biceps. The difference of relations between the nerve and artery in different parts of the arm is owing rather to the undulating course of the vessel, for that of the nerve is straight.

At the bend of the elbow, the brachial artery, C, Figure 2, passes exactly midway between the inner condyle of the humerus, G, and the outer margin of the supinator radii longus muscle, S. The tendon of the biceps, *a*, sinking to its insertion into the tubercle of the radius, is here close to the outer side of the vessel; and the brachialis anticus muscle, F, supports it, and the median nerve. Opposite the inner condyle, the artery is borne forwards by the brachialis muscle; but below this point it sinks backwards between the adjacent borders of the supinator longus, S, and pronator teres muscle, R, and here, H, divides into three principal branches—the radial, the ulnar, and the interosseous. Above the joint it gives off an anastomotic branch; and below the joint we find the ulnar artery giving off a recurrent branch to pass behind the inner condyle; while from the radial artery is derived a similar branch on its own side. The median nerve, D, passes under cover of the pronator teres, and traverses the forearm in a straight direction midway to the wrist, and beneath the superficial flexors, M P N. In its course this nerve gives off the anterior and posterior interossei branches, and numerous others, to the superficial and deep flexors. The ulnar nerve, E, passes behind the inner condyle, and enters the forearm between the origins of the flexor ulnaris, Q, and superficial flexor communis, N. In the forearm the ulnar, like the median nerve, rests on the deep common flexor.

From its origin in front of the tubercle of the radius to the carpal end of that bone, the radial artery, I, Figure 2, passes in a comparatively superficial course. It is only necessary to turn aside the inner border of the supinator muscle to expose this vessel in any point. At its origin it is approached by the radial nerve, which is a branch of the musculo-spiral. The radial nerve closely accompanies the artery in the upper two-thirds of the forearm, and then, leaving the vessel, passes beneath the tendon of

FIGURES OF PLATE XII.

Figure I.

A. Biceps muscle covered by fascia. — B. Basilic vein and internal cutaneous nerve. — C. Brachial artery and venæ comites. — D. Cephalic vein and external cutaneous nerve. — E. Median basilic vein. — F. Median cephalic and deep communicating veins. — G. Lymphatic body.—H. Fascia.—I. Radial artery, veins and nerves.—J. Ulnar artery, veins and nerve. — K. Pisiform bone and tendon of flexor ulnaris muscle. — L. Palmaris brevis muscle.

Figure II.

All parts except the following are marked as in Figure I.

A. Biceps muscle. — *a*. Its radial tendon. — *a**. Its aponeurosis. — D. Median nerve. —E. Ulnar nerve. — F. Brachialis anticus muscle. — G. Inner condyle of humerus. — H. Place of division of the brachial artery. — M. Flexor carpi radialis muscle. — N. Flexor digitorum sublimis muscle. — O. Flexor longus pollicis muscle. — P. Palmaris longus muscle. — Q. Flexor ulnaris muscle. — R. Pronator teres muscle. — S. Supinator radii longus muscle.

the supinator muscle, to be distributed to the integuments at the back of the wrist and hand. In the upper part of the forearm the broad fleshy portion of the supinator muscle overlaps the artery; but towards the wrist, where that and the flexor carpi radialis muscle, M, end in tendons, the vessel between them is covered merely by the fascia, and here it is only accompanied by one or two small veins. The superficial position of the radial artery near the wrist, its being supported by the radius, against which it may be compressed, and its being of larger caliber and more exposed than the ulnar, are the circumstances which render the pulsations of the former vessel more readily and accurately ascertainable by the touch than those of the latter. But it would appear that the comparatively greater distinctness of the pulsations of the radial artery is chiefly owing to the fact of that vessel making an abrupt turn around the upper end of the metacarpal bone of the thumb, and thereby occasioning some degree of impediment to the current of blood through it at that part.

The ulnar artery from its origin, H, to where it enters the hand on the inner side of the pisiform bone, K, of the wrist, passes under cover of the superficial flexors. Its upper end is concealed by the pronator teres; its lower part is between the flexor ulnaris, Q, and adjacent tendon of the flexor communis, N. Its middle part is deeper than the other two, for here it is overlaid by the fleshy portions of the muscles. About the middle of the forearm it crosses at an acute angle under the median nerve, and, leaving this, approaches the ulnar nerve, which it accompanies to the hand—the nerve lying close to the inner side of the vessel. Small branches of the artery loop inwards over the ulnar nerve. Near the wrist the ulnar artery may be felt in the living body beating as the ulnar pulse; but very obscurely, however, on account of the tendons overlying it. In the middle of the wrist, the median nerve, D *d*, is superficial, and enters the hand beneath the anterior annular ligament with the tendons of the superficial common flexor muscle.

Having noticed the relations of the principal vessels and nerves at the bend of the elbow and forearm, we may, before tracing their continuations in the hand, re-examine them in reference to venesection. The skin covering the bend of the elbow is thin and delicate in texture; and the subcutaneous adipose tissue in which the veins are embedded being loose and soft, allow these vessels, while distended, to be discerned beneath the surface. In some individuals, particularly females, the veins here are much obscured by the adipose tissue and skin. In males, especially of the labouring class, they are very conspicuous at all times. On fully extending the forearm, the artery may be felt pulsating about the level of the inner condyle, but close to the end of the biceps. Below this point the fibrous band of the biceps tendon on the stretch bridges the artery, renders its pulsation less evident, and bears forward from that vessel and the median nerve, the median basilic vein which lies over it; but the interval thus occasioned is so small, that the point of the lancet should be always guarded. The utmost caution, however, will not in all instances prevent the occurrence of arterial hemorrhage; for it not unfrequently happens that a large artery (the ulnar or the radial), arising higher than usual from the brachial, passes here over the fascia in company with the basilic vein, and thence in a superficial course towards its usual position at the wrist. This variety is more frequent with the radial than with the ulnar artery. I have, however, more than once noticed a well-marked instance in which the latter vessel, for its whole length, pulsated thus subcutaneously in the living subject; and one case of aneurismal varix, in which dissection showed a high division of the arteries, with the additional circumstance of an union of them again at the bend of the elbow. The median basilic vein is generally more conspicuous than the median cephalic; but the latter vessel not being in the course of the artery, is the safer of the two for the operation. In opening either vein, the cutaneous nerves which happen to lie on it are liable to be wounded, and this is particularly the case with the median cephalic, which is much complicated with the nerves. But perhaps the precaution as to this matter is not so urgent as some would appear to suppose. The permanent contraction of the muscles occasioning flexion of the elbow joint, which sometimes follows a wound of these nerves (if, indeed, it be from a wound of these, and not of the median nerve), is an effect I cannot account for upon the physiology of nerves as at present taught.

In order to distend the veins for venesection, their ascending currents require to be arrested by a band passed around the arm above the point to be incised. To effect this object, a moderate pressure will be sufficient; for if it be too great, we obstruct the circulation through the artery, and the veins not receiving the recurrent blood will not be distended; whereas, if the pressure be too slight, the circulation in the veins will not be impeded, so as to render them turgid. By exercising the muscles, the pressure urges the deep veins to empty themselves into the superficial ones, and besides this, the arterial current is rendered more rapid. To make the section lengthwise in the vein, is the safer way in all respects, for the nerves, passing parallel with the vessels, have a better chance of escaping injury; the vein also is less apt to swerve from the lancet, and hence less likely to endanger the artery. In performing this operation, it will be noticed that in pressing with the left thumb upon the vein immediately below the part to be opened, that vessel becomes less distended than previously. This is owing to our interrupting the current from below, and also to the fact that the blood in the part of the vessel between the thumb and the constricting band above passes from it through the communicating vein, F, Figure 1, which sinks beneath the fascia, near the biceps tendon, to join the venæ comites. To obviate this occurrence, it will be only necessary to place the thumb below one or more of the next communicating branches. As long as the bleeding is to be continued, the band should of course be left in its position, for as soon as it is removed, or even loosened, the flow ceases. In lean muscular subjects the veins generally appear sufficiently large, passing over the fleshy part of the forearm, and in this situation one or other of them may be incised with all the desired effect, and with most safety to the brachial artery.

On removing the integument from the palm of the hand and fingers, we find the subcutaneous cellular membrane interspersed with much granular fatty substance, and, in this, numerous small branches of arteries, veins, and nerves, serving the skin as the special organ of touch.* When this substance is cleared away, the palmar fascia appears, having, in front of its upper part, the palmaris brevis muscle, which consists of a thin layer of fibres, stretching between the muscles of the thumb and the inner border of the hand, and evidently for the use of contracting the palm transversely. In the middle of the palm the fascia is of considerable thickness, but where it invests the muscles of the thumb and little finger it is thin. In front of the carpus we find a remarkably strong band of fibres (the anterior annular ligament) attached externally to the scaphoid and trapezoid bones, and internally to the unciform and pisiform bones. The flexor tendons, with the median nerve, pass under this ligament to the hand, and play freely in the bursal canal formed between it and the carpus. The fascia of the forearm being connected to the upper edge of this band, and the palmar fascia to its lower, while the latter is joined to the bones and tendinous parts of the metacarpo-phalangeal joints, it will be observed how, when matter forms beneath the fascia of the palm, it can readily make its way into the forearm by passing up beneath the annular ligament along the flexor tendons.

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* In naming the integuments of the palm as being the seat of one of the *special* senses—that of touch, I am far from believing (if it be believed by any) that the nerves supplying it are of a special class, different in function from those distributed to the skin in any other situation. The fact, indeed, admits of no argument, while we see that the nerves which supply the arm and forearm are those which ultimately branch in the hand. While, however, we are conscious that in the hand alone resides an ability to afford us intelligence of the qualities of things not enjoyed by other parts of the body, we are induced, while aware of the effect, to trace it to its cause. If the nerves of the hand be the same, both in substance and function, as those elsewhere, it is evident that to the structural qualification of the part must its special endowments be principally, if not solely attributed. In the radiating form of the organ, we see its fitness for performing motions of such great variety and precision. To that character of form is also due the fact, that the nerves of common sensation which pervade the body generally, are in the hand rendered peculiar and particular, capable of appreciating the variations of surface, weight, and measure, the configuration, consistence, and numerous other properties of matter, which elsewhere, owing to the place of their distribution, they are incapable of. In the organization of the hand, as a whole, therefore, we must fix the seat of that innervation which informs us of those properties, for while we feel with the cutaneous nerve, we weigh and measure with the muscles moving the bones.

Reflecting upon those facts in regard to the hand, seeing that to its form is mainly due its function as an organ of special sense, I have long since entertained the idea that the nerves which we call *special*—that of Hearing, Tasting, Smelling, and Vision, as well as those of Motion and Sensation, are as structurally identical, the one to the other, as the very arteries themselves which accompany them are to each other; and hence that it will ever be as vain for us to seek for a structural distinctness between the nerves, corresponding to and explanatory of their several functions, as it would be to look for a structural distinction between the hepatic, the renal, the spermatic, and other arteries, with the object of accounting for the several secretions elaborated from the homogeneous blood of those vessels. Starting from this point, therefore, which I firmly believe to be the radical truth upon which to establish the physiology of the nervous system in general, the first question which suggests itself is, upon what circumstance depend the functional differences of nerves? *Upon the form and structure of the organ or part in which they ramify.* A nerve is *visual* in the optical apparatus constituting the eye; *auditory* in the ear; *gustatory* in the tongue; *olfactory* in the nasal cavity; *motor* in the muscles, and *sensory* everywhere throughout the surface, according to the physical properties of the part with which it is connected; but as to the fact of all nervous matter, as well the cerebro-spinal centre as the periphery, being *substantially* the same, I have so little doubt, as to believe that by a change of place and destination any nerve may serve the function of any other. Actual evidences of this, indeed, may be had on examination of some of the lowest class of vertebrate animals, in which that nerve which *is numerically the same* throughout all species, *is not functionally the same.* The serial homology of the cranial and the spinal vertebræ indicates the serial homology of the cranial and spinal nerves which they transmit, nor does this fact appear to me less evident in nature than that the same kind of parts on opposite sides are anatomically identical.

PL. XIII.

Fig. 1.

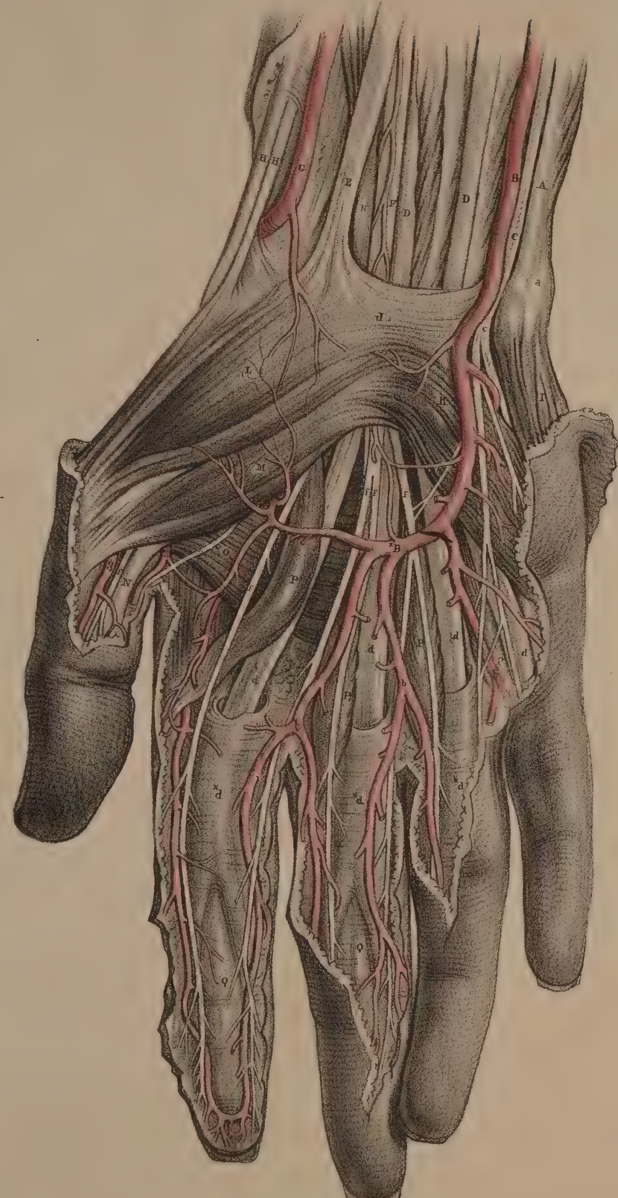


Fig. 3.

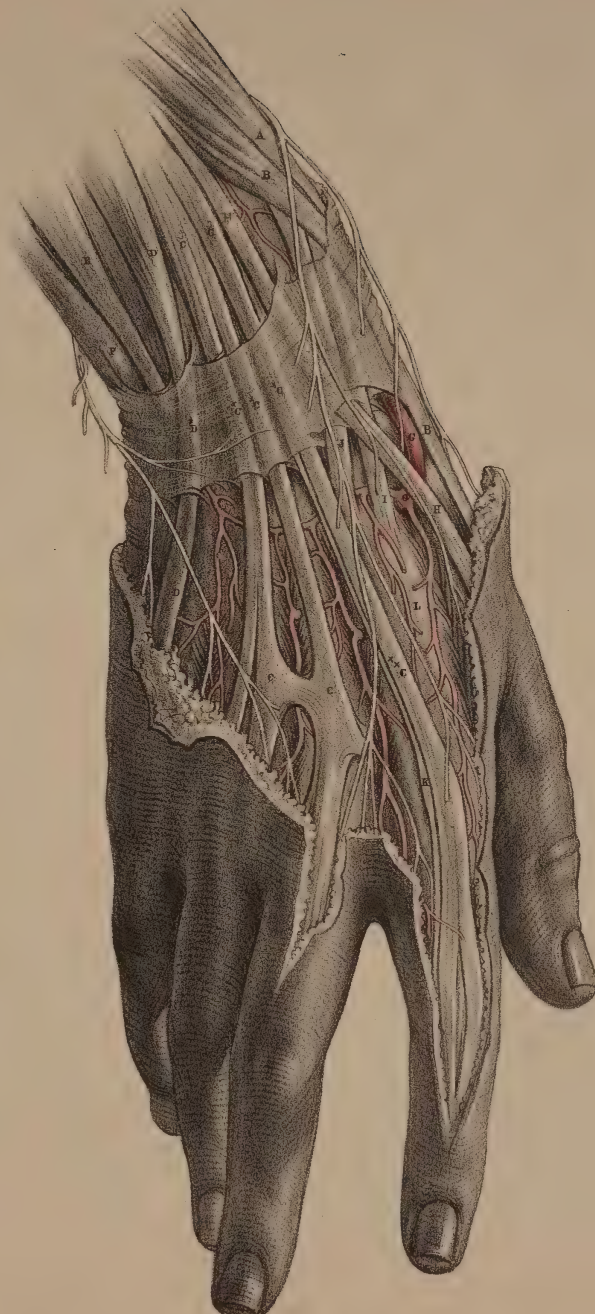
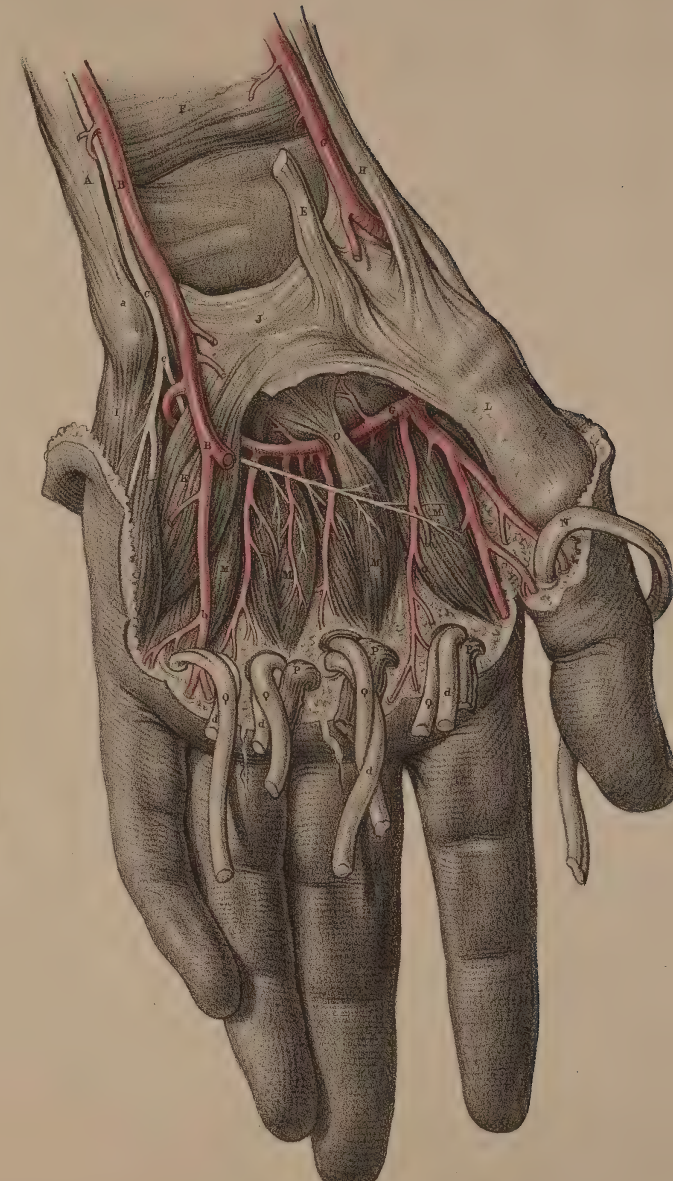


Fig. 2.



[?] & N Hanhart, Imp[t]

The principal arteries and nerves of the forearm traverse the front of the wrist and enter the palm, to be distributed to the structures here situated, which are of greater number and variety than those on the back of the hand. When we have removed the fascia and subjacent cellular substance from the palmar and dorsal surfaces of the wrist and hand, we find the vessels, nerves, tendons, and muscles, although arranged in definite and beautiful order, exhibiting what may appear on the first view, owing to their great number, rather complex relations. The course of the arteries and nerves may be best explained after noticing the form, position, and attachments of the several muscles in reference to the osseous parts.

As the muscles of the arm act on the forearm through the medium of the elbow joint, so all those of the forearm act on the hand, by the intervention of the wrist joint. In the hand, moreover, we find a set of small muscles proper to it, and so placed as to assist and direct the more powerful muscles of the forearm in their action on the fingers generally, and on some of the fingers specially,—viz., the thumb, the fore, and the little finger. The skeletal hand being naturally divisible into many articulating parts, all of which are capable of concertive motion, and each of distinctive motion, the muscles are disposed in an order to serve both requirements.

In the hand the larger muscles of the forearm end in tendons—an anatomical form which, without diminishing the effective power of those muscles, gives them greater precision in moving the fingers, and admits of the necessary slender proportions of these. The small muscles proper to the hand exhibit an arrangement in furtherance of the same ends. They are situated in the palm, between the bones of which free motion is least required, and where their collective bulk, so far from rendering the organ unwieldy, contributes to perfect it for its prehensile and tactile functions. The metacarpo-phalangeal members, five in number, consist each of four bones, articulating end to end, and in linear series. The fingers, possessing three phalanges each, are parallel; the thumb, having but two phalanges, is opponent to them. This difference I find to be owing to an early union of the element of the first with the second phalanx of the thumb, or with its metacarpal bone. The thumb, *minus* a phalanx, shortened in that degree, parted from and turned to the palmar aspect of the fingers, is thereby rendered more fit as the opponent digit of the other four, and endows the hand with a *fourfold* advantage, not attainable if the thumb were in any other relative position. The palmar muscles form three groups, viz., that which surrounds the metacarpal bone of the thumb; that which is disposed in a similar manner around the metacarpal bone of the little finger; and that which occupies the middle of the palm. The metacarpal bones, thus united by the muscles over which the fascia and integument are stretched, are thereby limited in their motion and constitute the clubbed palm, which serves, among other uses, as a basis of support to the free individualized fingers. Of the ligaments considered surgically, it is only needed to observe, that those of the carpal joint are short, close, and numerous, as the bones they unite, while those of the phalangeal joints, which are formed principally for flexion and extension, are placed laterally, in a more condensed form than behind and in front, for in these situations the tendons playing in strong sheaths of transverse fibres supply their place.

The hand, pendent in a state of repose, assumes a form indicative of the relative tonic power of its antagonising muscles. The carpal flexors and extensors being of about equal power and number, allow the hand to hang midway by the wrist, between both their influences. But the digital flexors being more powerful than the extensors, and being, moreover, aided by the palmar muscles, cause the fingers, particularly the fourth and fifth, to bend somewhat towards the palm. The thumb, on the contrary, under the control of its three extensors, whose united force is greater than that of its single flexor, appears more extended than flexed. When this natural balance of the opposite muscles becomes disturbed, either by voluntary effort or by the disseverment of either tendon, the joint obeys the action of the muscle which is entire. The following are the anatomical effects of amputation of the several parts of the hand: 1st. In amputating the *last phalanx* of either of the two *middle fingers*, we divide the end of the *common extensor tendon*, but as this has also a distinct attachment to the *second phalanx*, it is prevented retracting, and is still capable of extending the remaining part of the finger. The tendon of the *deep common flexor* is also divided, and having been connected only to the *last phalanx*, retracts free in its sheath, useless to the finger. The *second phalanx* of either of those fingers is then acted upon by the equal powers of a *single flexor* and *extensor*. But when the same part of either the *fore* or *little finger* is amputated, *two extensors* joined oppose the *single effective flexor*, and the finger takes a position accordingly. 2nd. When the *second phalanx* of either of the *four fingers* is amputated, the tendons of *both common flexors* are divided, and, retracting, leave the *first phalanx* almost entirely influenced by the *extensor*. The *lumbricales* and *interrossei* are then the only opponents of the *extensor*, but their flexive power is comparatively weak. 3rd. When amputation is performed at the *metacarpo-phalangeal joints*, we divide the tendons of *all the digital flexors and extensors*, together with those of the *lumbricales* and *interrossei*, and, having no points of insertion into the remaining bones of the hand, those muscles are rendered useless. 4th. Amputation of the phalanges of the thumb is followed by anatomical effects somewhat different to those of the operation on the fingers. When the *last phalanx* of the thumb is amputated, the tendon of the *long flexor* is divided, and becomes useless. Flexion can then only be performed by the *short flexor*, whose action, owing to its disadvantageous insertion, is very inefficient. The *third extensor tendon* is also divided, but the *second*, having a distinct insertion into the *first phalanx*, acts upon this part. 5th. In amputation of the *first phalanx* of the thumb with the *sesamoid bones*, we divide all the tendons except that of the *opponens*, inserted into the *anterior end* of the *metacarpal bone*, and that of the *first extensor*, inserted into its *posterior end*. 6th. When the hand is amputated across the *metacarpus* all the *digital muscles* are divided, but the remaining part of the member is still moveable by the *carpal flexors* and *extensors*. 7th. By amputating the hand at the *wrist*, we divide all the muscles which act *directly* on it. 8th. When a tendon having but one insertion is severed, its proximal end retracts from its distal end so far as to prevent union between them, and consequently the power of the muscle over the neighbouring joint is lost.

The hand being composed of the palm and five radiating digits, and the capability of the organ being chiefly due to the relative position of those parts, it follows that its *functional decline* must be more than commensurate with its *quantitive loss*. The relative value of any part of it is, therefore, to be estimated according to its *relative position*, and when planning an amputation this circumstance should first be well considered, lest we sacrifice the more important part to the less. The following observations will serve to illustrate this subject: 1st. The more the hand is truncated the less efficient as a tactile and prehensile organ it is rendered. If the *distal end* of any *phalanx* be diseased, without involving its *upper articular end*, it would be preferable to amputate the part *across the phalanx* than at its upper articulation, for by the former measure we leave the tendons holding their natural points of insertion, whereby the remaining part of the finger will prove the more capable. In sparing a joint, then, at any situation, we not only save quantity, but retain function. 2nd. The *lateral parts*, as enjoying a greater freedom of motion than the central parts, are of more value than they. 3rd. A part which is *permanently flexed* can answer a better use than if it were permanently extended, and therefore when, as by a division of the tendon, we convert the former position to the latter, we only render the inconvenience worse than it was. The presence of a part, in any position between extreme extension and flexion, is, however, preferable for some reasons to its absence. 4th. When a *distal phalanx* is removed at the *joint*, the proximal one is rendered less capable of motion, for the

FIGURES OF PLATE XIII.

Figure I.

A. Flexor carpi ulnaris muscle; *a*, pisiform bone.—B B*. Ulnar artery and superficial palmar arch; *b b b*, its digital branches.—C C. Ulnar nerve.—D D. Superficial flexor communis digitorum muscle; *d d d d*, its four tendons, *d* d* d**, in their digital sheaths.—E. Flexor carpi radialis muscle.—F. Median nerve; *f f f f*, its branches.—G. Radial artery; *g g*, its branches to the thumb.—H H. First and second extensor pollicis muscles.—I. Abductor minimi digiti muscle.—J. Annular ligament.—K. Flexor brevis minimi digiti muscle.—L. Abductor pollicis muscle,—M. Opponens pollicis muscle.—N. Tendon of flexor pollicis muscle.—O. Adductor pollicis muscle.—P P P P. Lumbricales muscles.—Q Q. Tendons of deep flexor communis digitorum muscle in their digital sheaths.

Figure II.

All parts except the following, are marked as in Fig. 1:—F. Pronator quadratus muscle.—G G. Radial artery and deep palmar arch.—L. Metacarpal bone of the thumb.—M. Interosseal muscles.

Figure III.

A B. First and second extensor pollicis muscles.—C C C. Extensor communis digitorum muscle, bound down by C* C* C*, the annular ligament.—D. Extensor minimi digiti muscle.—E. Extensor carpi ulnaris muscle.—F. Lower end of the ulna.—G. Radial artery.—H. Third extensor pollicis muscle.—I J. Extensor carpi radialis longus and brevis muscles.—K. Tendon of indicator muscle.—L. Metacarpal bone of the forefinger.

tendons which acted on the former part aided the motions of the latter. When the *proximal phalanx* requires removal, it, as being the support of the distal one, generally necessitates the sacrifice of the latter also. 5th. The *thumb*, as being the *opponent digit*, is, with a *finger*, of more varied use than any number of fingers without a thumb. But the thumb *alone* is even less capable than a single finger. 6th. The *forefinger*, as being *next* the thumb, is of more value than any other finger. 7th. Two *adjacent* fingers, with or without the thumb, prove more convenient than two distant from each other. 8th. The loss of the *last phalanx* of the thumb is greater than that of an entire finger, but with the remainder of the thumb and any finger the use will prove greater than that of which any two entire fingers are capable without the thumb, for *parallel* members are less efficient than those in opposition. 9th. The deprivation of the fingers and thumb is a loss equalling the subtraction of five parts from an integer of six. The *metacarpus* is the sixth part, and any quantity by which it is *plus* or *minus*, renders its use *greater* or *less*. While, with any first phalanx, it retains the faculty of prehension in some degree, it can, even though reduced to half or even a third, perform, by the wrist joint, the motions of *flexion*, *extension*, *pronation*, and *supination*, by which an artificial substitute for the hand becomes the better counterfeit of nature. 10th. *Supernumerary digits*, which are motionless and inconformable to the direction of the others, are both useless and a deformity. 11th. A *fifth* finger, even though it be anatomically similar to, and as capable as the others, may, from its *singularity*, require removal. 12th. The *carpus*, as consisting of *eight distinct bones*, may, for a very considerable time, have its disease isolated to one or a few of them, in which case, by *excision* of the affected part, the hand can be saved from amputation.

The arteries of the upper limb usually accord in form and number with its osseous skeleton. In the arm the principal artery is single alongside of the humerus; in the forearm it branches doubly with the radius and ulna, while a third branch follows the interosseal ligament, which may be regarded as the connecting part of those bones arrested in the primordial stage of the ossific process, to allow of their motions of pronation and supination; in the hand it subdivides equally with the digits, whether these be, as usual, five in number, or supernumerary ones be developed.

The *ulnar* artery, B, Figure 1, passing over the anterior annular ligament, close to the outer side of the pisiform bone, enters the palm under cover of the fascia, the palmaris brevis, and the thick layer of granular adipose substance here situated, and then turning towards the middle of the ball of the thumb, forms over the long flexor tendons, the *superficial palmar arch*, B,* with its curve downwards. From the convexity of the arch, the digital branches, *b b b*, three or four in number, arise; and each of these passing straight to a point a little above the interdigital clefts, subdivides into two others, which course, one on each of the anterior adjacent lateral borders of two fingers. A single finger is thus supplied by two principal arteries of distinct origins in the palmar arch; and on tracing them to the tip of each finger, they appear terminating by direct anastomosis, the one in the other.

The *radial* artery, G, Figure 2, having gained the outer border of the wrist, passes beneath the extensor tendons of the thumb, and after winding abruptly around the head of the first metacarpal bone, L, enters the palm, where it forms *the deep palmar arch*, O G, between the long flexor tendons and the upper part of the metacarpus. The principal branches which it gives off in this course are these:—*one* (superficialis volæ, Figure 1), which anastomoses in front of the short muscles of the thumb, with the end of the superficial arch;—a *second*, Figure 2, which arises between the heads of the first and second metacarpal bones, and passes to supply the thumb and contiguous side of the forefinger, which parts are not served by the ulnar artery,—a *third*, which is given off near the last, and ramifies over the back of the wrist, Figure 3, where it anastomoses with the interosseal branches;—and a *fourth*, the termination of the vessel which joins the *ramus profundus* of the ulnar artery between the origins of the short muscles, I K, Figure 2, of the little finger. In the palm the deep arch sends branches backwards between the metacarpal bones to the dorsum of the hand, whence they turn upwards to anastomose with those on the back of the wrist, and downwards to supply the backs of the fingers, and to anastomose with the ulnar digital branches in front. In the tip of the forefinger, Figure 1, we notice that a branch of the radial artery directly ends in that derived from the ulnar. Besides these principal points of anastomosis between both vessels in the hand, there are countless others noticeable among their minor branches. The nerves supply the fingers in an inverse order to that of the arteries. The median nerve, F f f, Figure 1, branches from the centre of the palm to the thumb, the fore, the middle, and adjacent side of the next finger; while the ulnar nerve, C c, branches to the little and adjacent side of the next finger. On the back of the hand the radial nerve supplies the skin of the thumb, the forefinger, and the near side of the middle; while the dorsal branch of the ulnar nerve serves the little finger, the next, and the other side of the middle finger. The parts deeply situated in the palm are supplied by that branch of the ulnar nerve which follows the *deep branch* of the ulnar artery.

The *radial* artery may be easily exposed for deligation in any part of its course through the forearm. In the upper third of the forearm, where the inner border of the long supinator covers the vessel, if an incision be made over it through the skin and fascia, and the margin of that muscle be turned outwards, it will be found with the venæ comites, and having the nerve on its outer side. In the middle of the forearm, the same parts being divided and separated, the artery, with the veins and nerve, will appear in the same relative position. Near the wrist the artery passes midway between the tendons of the radial flexor and long supinator, and is covered only by the skin and fascia. On dividing the latter structures for about an inch in extent along the direction of the artery, this will be found still between the venæ comites, but unattended by the radial nerve.

The *ulnar* artery being throughout its course more deeply situated than the radial, the operation for exposing it becomes the more difficult. The direction of the ulnar artery would be very accurately indicated by a line drawn from the middle of the bend of the elbow to the pisiform bone. In order to reach the artery in either of the upper two-thirds of the forearm, the superficial flexors will have to be divided obliquely, and this being accomplished, and the parts retracted, we meet with the median nerve (not the ulnar) here, in company with the vessel, and crossing over it at an acute angle. Excepting, however, in cases of wounds, the operation of tying the vessel in this situation can never be called for, while with greater facility, and the attainment of all other requisites, it can be exposed and tied nearer the wrist. In the latter position the artery may be brought in view by dividing the skin and fascia in a line between the tendons of the flexors ulnaris and communis; and on turning those parts aside, the vessel will be found between its venæ comites, and with the ulnar nerve close to its inner side.

The frequent anastomosis occurring between the branches of the radial, ulnar, and interosseal arteries in the hand, is the cause why a hæmorrhage occasioned by a wound of either of those vessels, cannot be commanded by simple deligation of its proximal part above the wound. If for a wound in the palm we tie the radial or ulnar artery at the wrist, we shall find the bleeding still to continue, for though at the wrist the vessels are separate, their anastomotic continuity in the hand renders them as one. Hence, if the vessels of the palm be divided, and cannot be secured in the wound, it would be necessary, in order to arrest the hæmorrhage, to tie the ulnar as well as the radial at the wrist. Even this measure will not, however, in all cases, answer, and when it does not, the cause must then be that the interosseal arteries, which we know anastomose with the radial branches on the back of the wrist, and those with the ulnar branches, sustain the hæmorrhage. Now, as the three arteries generally spring from one point of the main vessel at the bend of the elbow, and unite again in the hand, they form, as it were, a *circle*, and hence it is evident, that in order to arrest the circulation through that circle, either the three vessels must be tied, or the common brachial trunk, of which they are the branches. The latter measure, as being less difficult, is generally chosen. But though the brachial artery be tied for a wound of the vessels of the forearm or the hand, and though it may seem that we have put in process that measure at the very fountain-head of hæmorrhage, it by no means follows that the object of the operation cannot be otherwise than surely attained. The failure, when it does occur, must then be owing to a high division of the brachial artery above the site of the ligature, either into one or other, or all three of the branches of the forearm, which, whatever be the variety in this respect, invariably anastomose in the usual manner in the hand, and thus, all the same, maintain the arterial circle. In consideration of all these circumstances, and with the desire of adhering strictly to the most rational rule in surgery, which commands as well *to do no more than is absolutely necessary*, as *to do no less*,—not, for example, at the risk of the limb, to tie the brachial artery for a wound of one of its branches, any more than, at the risk of hæmorrhage, to tie its branch for a wound of the main vessel; we should then look for the vessel in the wound, and there command the hæmorrhage by tying *both its ends*. Whenever this can be accomplished (and it always can be by extending the wound, if small, and the vessel deep), we need not then trouble ourselves concerning the "*anomaly*" in arterial distribution. It is to the isolated fact that mystery alone attaches, and on this we err. But when we view the whole great fact within whose span and compass, like an integer, all lesser facts are included, we arm ourselves with reason, and fence ourselves against mistakes and all mischances.

Fig. 2.

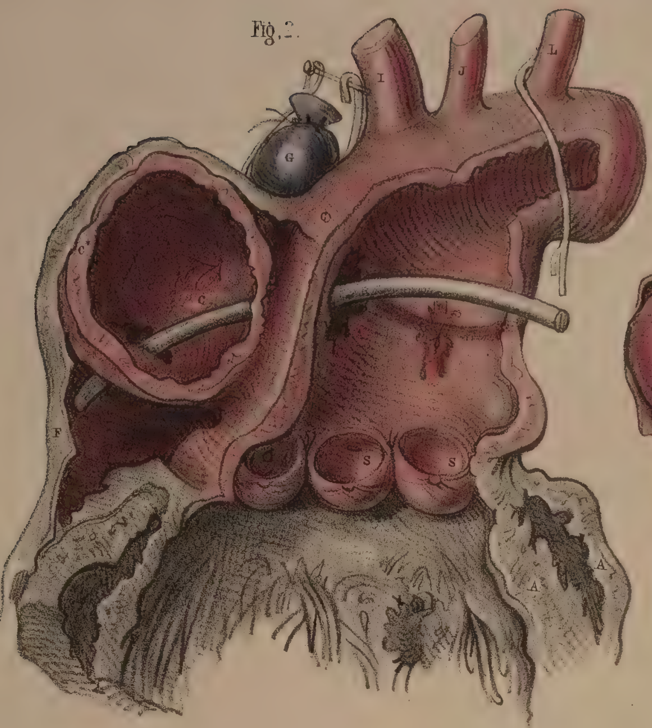


Fig. 3.

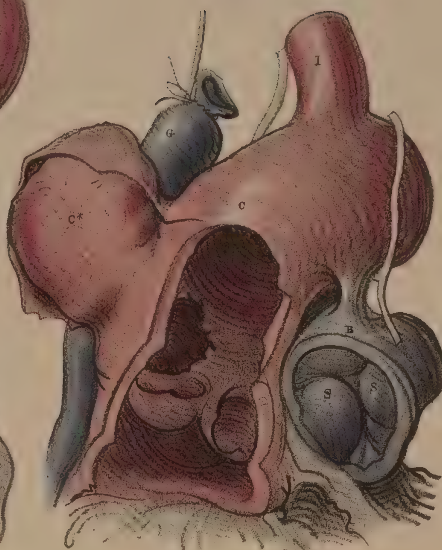


Fig. 4.

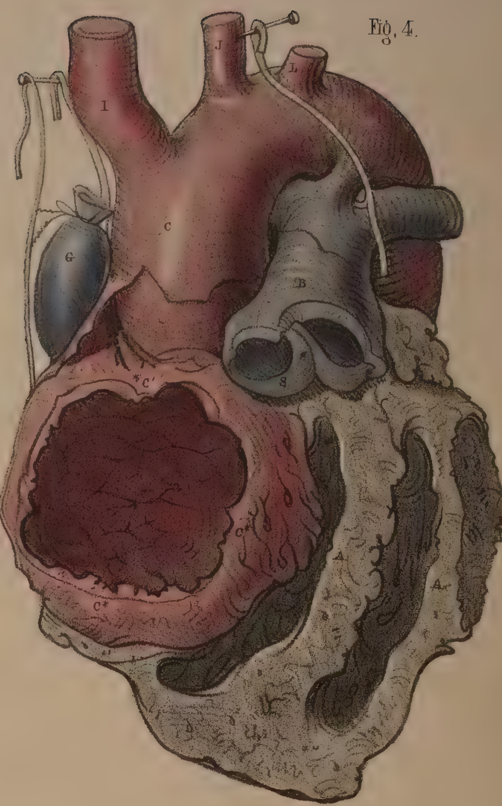


Fig. 1.

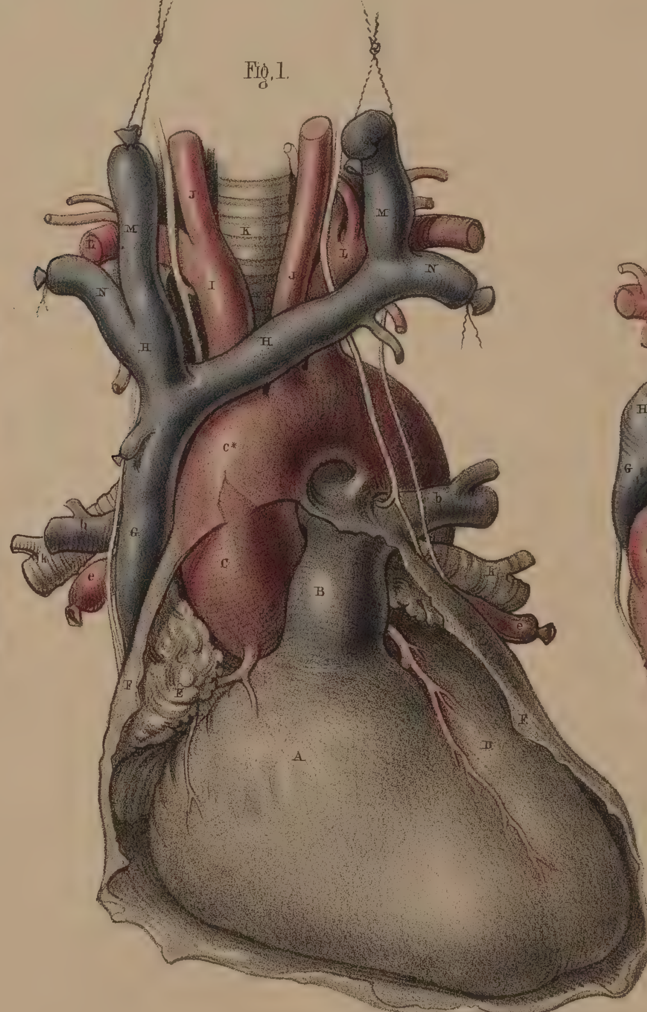


Fig. 5.

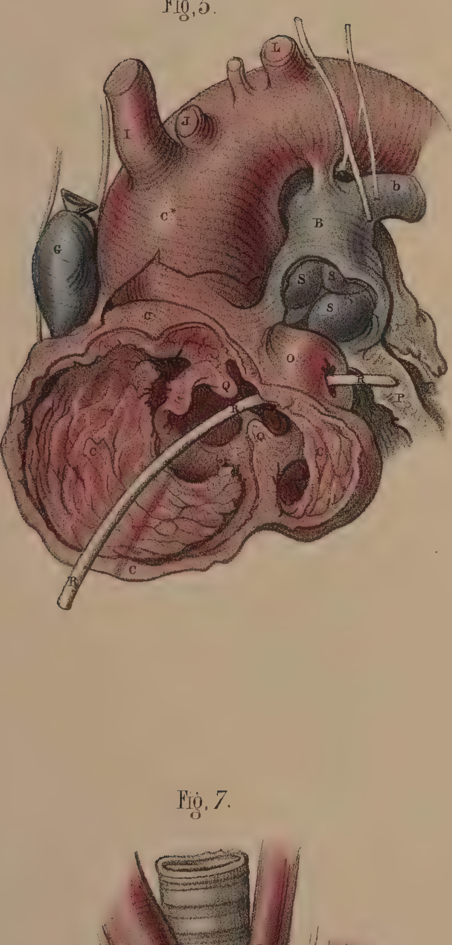


Fig. 6.

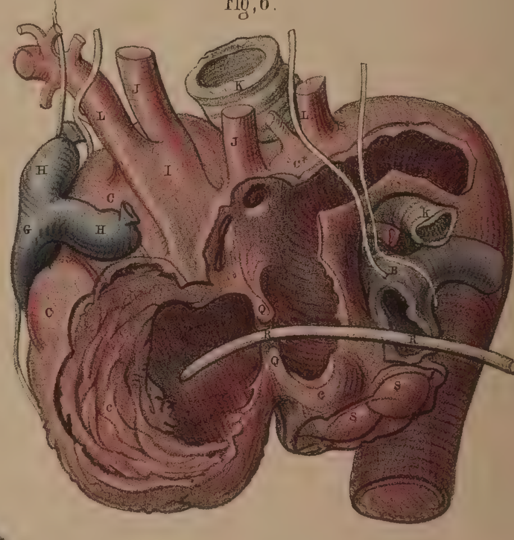


Fig. 7.

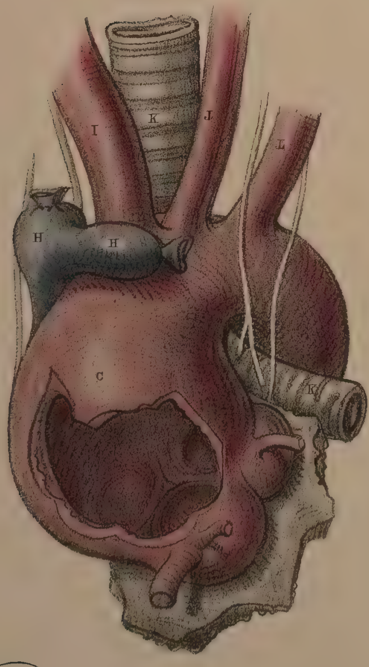


Fig. 8.

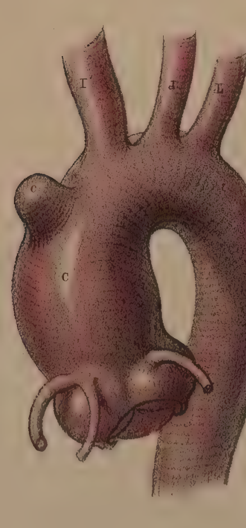
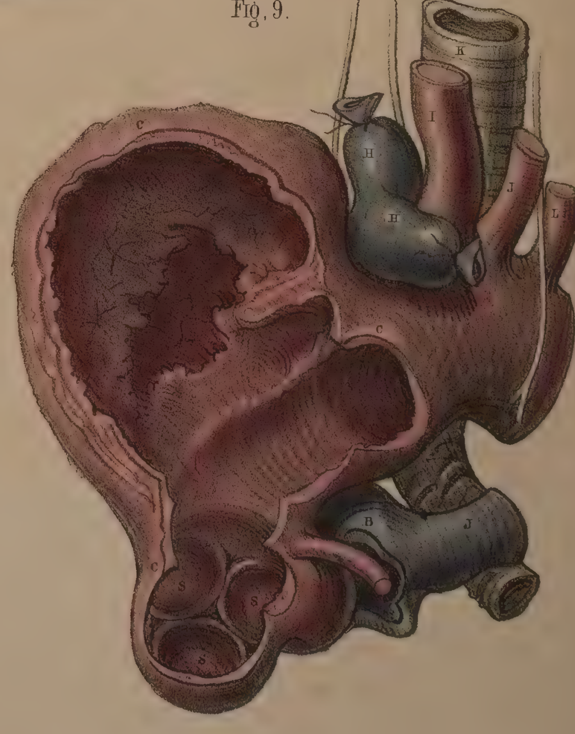


Fig. 9.



M & N Hanhart, Imp[t]

COMMENTARY ON PLATES XIV. XV. & XVI.

ANEURISM OF THE HEART, AORTIC ARCH, AND PRIMARY BRANCHES. MECHANISM OF THE CARDIAC—ARTERIAL AND THORACIC—VENOUS *DOUBLE* CIRCULATORY APPARATUS.

THE heart, which is the centre of the vascular system, is the only part of that system in which *true* muscular structure can be distinguished. Therefore as the *arterial* current is carried on solely by *muscular action*, the *heart* must be the only agent in giving that motion to the blood in the arteries. The heart is evidently as actively contractile as it is muscular; but the arteries are as evidently motionary by the heart's action alone, as they are non-muscular. The pulsation of an artery being synchronous with that of the heart must be caused by the heart; and as the impulse of the latter becomes weakened in the ratio of the distance from itself, this fact alone is sufficient to prove not only that an artery has no action originating with itself, but that its motion is simply of the *elastic* kind which results from the physical properties of the structures of which it is composed. Dissection cannot demonstrate that structure to be muscular, whose motion depends on other agency than its own, and this circumstance precludes the necessity of experiment. While we find a finger to be mobile by a muscle situated in the forearm, we do not want to prove the existence of muscular tissue in the finger. Nor while the motions of an artery are those of the heart, (the former commencing and ceasing with the latter,) need we seek to prove "arterial muscularity." Granted, however, that in an artery a *tonic* power exists; in which of the soft tissues does such a power not exist in some degree? But who is there that on comparing the *middle* coat of an artery with the substance of the heart's ventricle, (for in the broad contrast is the broad truth discernible,) can see their identity any more plainly than he can distinguish in the motion of an artery *three* kinds; that of *contractility*, of *tonicity*, and of *elasticity;* the one independent of the other, and all three distinct from the motion of the blood in that vessel leading from the heart? If the impulse of the ventricle on the blood, the passage of this through the artery, and the *elastic* reaction of that vessel be sufficient to account for all the phenomena actually manifested in the arterial current, (and doubtless they are sufficient,) what necessity then is there to search for that structure in an artery, which neither the evidences of the senses prove to exist, nor the evidence of reason shows to be a natural requirement? From these premises it may be deduced that, as an *aneurism* is the result of the *forcive dilatation* of the arterial coats through the medium of the blood, the *heart* being the *originator* of such force must be the *prime cause* of the aneurism, however much it may be aided to this effect by some *secondary or proximate cause*, such as *structural disorganization*, or some *peculiarity* in the *form* of a particular artery. The *proximity* of the *aortic aneurism* to the *left ventricle*, and the *greater frequency* of the disease in that situation, point directly to the *heart* as the *principal cause* in producing it; while, on the other hand, the *comparative rarity* of the *disease* in places *remote* from the *heart* is a negative evidence to the same conclusion. Seeing, therefore, that all aneurisms express in their forms the measure of the heart's action, the circulating forces first demand consideration, forasmuch as on these depend the common characters of the disease, wherever appearing,—its origin in the arterial system; its progress; its structure; its issue; and the one principle on which its cure is to be attained.

On reviewing the vascular system, as a whole, the structure of its several divisions appears to me to afford such unmistakeable evidence of the respective parts they play in the circulation, that I do not hesitate to set down the following propositions, though they be at variance with received doctrines:—1st, *The only active part the heart can take in the circulation is to propel, by ventricular systole, the blood through the arterial semicircle;* 2nd, *The vascular circle formed by the artery and vein is inactive, and serves but as a transmittent conduit for the blood from the heart centrifugally, and to it centripetally;* 3rd, *The current through the venous semicircle must therefore depend on some other influence than that of the heart or its vessels.* In support of these propositions I record the anatomical facts in the order and form in which they seem to me to serve.

The Heart is *duplex* in form. It consists of a right and a left organ, but these are so bound in apposition as to render the heart, in outward appearance, single. Each heart consists of an auricle and a ventricle, the chambers of which communicate. The two auricles are similar in form, structure, and capacity. The two ventricles are similar in the same respects, and this implies the symmetry of the heart as a whole. The auricles at the base of the heart are placed side by side; the ventricles forming the body and apex of the heart are also in apposition. By their touching sides the two auricles form a *septum*, which divides their cavities from each other. A dividing *septum* is in a similar manner formed between the two ventricles. The auricular and ventricular *septa* form a plane, reaching from the base to the apex of the heart, and corresponding with the general median line of the body, which marks not only the duality of every single organ, but that of the entire frame. Between the right auricle and ventricle a valvular apparatus (tricuspid) exists, and is so placed as to allow of the passage of blood from the auricle during its *systole* into the ventricle, when this is in its passive state; and also to prevent the reflux from the ventricle, when in *systole*, into the auricle while passive. A valve of similar form and function (bicuspid) is placed between the left auricle and ventricle. In the form of those valves is expressed the fact that the auricles are active only in respect to the ventricles, and can play no part in the general circulation, except thus locally. Corresponding with this very limited activity we find the auricles to be (compared with the ventricles) but as membranous bags with thin and scattered muscular fibres entering into their structure. The ventricles, on the contrary, have thick muscular walls, indicating that upon their action alone the passage of the blood through the arteries might be effected. The two ventricles are, however, unequal as to muscularity, and signify their relative powers in their forms. The left is more muscular than the right, and this accords with the difference in the area of the fields in which each has to propel the blood through its proper artery. The lungs being of much less dimensions, of more expansile structure, and more favourably placed in regard to the central circulating force than most parts of the body are, do not require the *right* ventricle to equal the left, or systemic organ, in power. Considering the heart, in its totality, according to this evidence of its structure, it will appear that its circulating force is to be estimated in regard to the

FIGURES OF PLATE XIV.

FIGURE I.—The heart and primary blood-vessels of an adult male, of their normal form and relative position.

FIGURE II.—The aneurism, CC, projects from the right side of the ascending aorta, C, and has ruptured into the pericardium, F.

FIGURE III.—The aneurism, C*, projects from the right side of the ascending aorta, C, within the pericardium.

FIGURE IV.—The aneurism, CC,* springs from the root of the aorta, C, and nearly obliterates the cavity of the right ventricle, AC.

FIGURE V.—The aneurism, CC, of the root of the aorta, has ruptured its left side, O, into the right ventricle.

FIGURE VI.—The aneurism, CC, formed of the right side of the ascending aorta, CC,* flattens and obstructs the innominate artery. The trachea is displaced.

FIGURE VII.—The ascending aorta, C, is uniformly dilated.

FIGURE VIII.—A small pouched aneurism, C, projects from the aortic arch in front of the root of the innominate artery, I.

FIGURE IX.—A large aneurism, formed of the right side of the aortic arch, compresses the vena cava and nerves backwards, and the trachea to the left side.

ventricles only, for the auricles are merely transmittents of the blood to them. Now, taking either ventricle separately, we find it, like all other muscular organs, capable of only *one* kind of *active* motion, viz., *contraction.* This motion is the *systole* of the ventricle, while its *diastole* corresponds to the *relaxation* of muscles in general, or that *passive* state which is the *opposite* to *action.* For the ventricle, or auricle, therefore, to perform an *active* diastole in opposition to its active systole becomes no less an impossibility than for any *single* muscle to be *actively* relaxative as well as contractile. Nor is there any feature in the mechanism of the heart which would indicate the probability that the *contraction* of one compartment can effect the *relaxation* of another; for this cannot be true of the ventricles, since the *systole* of both is *synchronous*, and their *diastole* the same; while between the auricle and ventricle there exists no such balance of muscular power as would be adequate to effect such a reciprocal change of state. The *active* force of the heart, therefore, being reducible to its *systole*, the motion imparted to the blood by the ventricle in this action can be but in one direction, viz., *from the centre of the body to the periphery through the arteries.* From each of the ventricles a single main artery arises and branches,—that of the right ventricle to the lungs, that of the left to the system generally, not excepting the lungs. Both arteries, therefore, form two separate systems of branches, and thus the two hearts, anatomically distinct, can only combine for a oneness of function, in maintaining the general economy of the circulation, under this condition, viz., the *artery* of the *right* organ terminates in the *veins* of the *left*, in the *lungs*, while the *artery* of the *left* terminates in the *veins* of the *right*, in *all parts of the body.* The facts which serve to illustrate the systemic circulating forces will hence also apply to the pulmonary.

The aorta exhibits a structure quite different to that of the left ventricle, from which it arises. The middle coat of the vessel is not only discontinuous with the muscular substance of the ventricle, but between both structures there appears no community of character, either physical or vital. I would not venture to make this assertion of the difference between osseous, cartilaginous, or even ligamentous tissue, for there is a histological transition between them, but between the fibrous coat of the aorta and the muscular substance of the ventricle there exists, as far as I can judge, as marked a dissimilarity of structure as between tendon and muscle. The ventricular orifice is surrounded by a ring of tendinous structure, by which the artery is united to the ventricle; and this ring interrupting transition, forms the line of structural demarcation. Whether in the living or the dead state we find the principal characteristic property of the middle coat of the artery to be *elasticity*, and of this the ventricle is deprived; whereas, in the living state, the ventricle is actively contractile, and the motion which it imparts to the blood tells both synchronously and rhythmically on the artery receiving the blood. Elasticity is sufficient to account for this motion in the vessel; and thus here, as elsewhere, the balance between cause and effect brings the argument to its issue. The *heart*, being *muscular*, may be (as it is) actively propulsive of the blood; while the *aorta*, being *non-muscular*, can have no such power, and therefore has not.

The arteries are structurally the same as the common trunk from which they are derived. This is demonstrable: and therefore what is true of the aorta must be true of them. In no situation do we find them more capable than the aorta to exert any *active* power in aid of the heart's impulse on the blood passing through them. On the contrary, by their very form and structure, they but lessen the heart's force, nor need we doubt (according to the law of *nihil frustra*) that there is such necessity for the circumstance, that any *marked activity* on their part would be rather an unfitness than otherwise. From their single cardiac origin to their minutest multitudinous ramifications in the periphery of the body, the arteries form an uninterrupted series of decreasing canals, whose total area being far greater than that of the aorta must by *diffusion*, by *distance*, by *capacity of space*, by *friction surface*, and also by the *opposing surface*, which the angles (right, acute, and obtuse) described by those vessels everywhere, exhibit, serve to *weaken* the central circulating impulse on the blood. If the arteries possessed any *active* contractile power, this could only be available for furthering the circulation by a quick *vermicular motion from the heart outwards*, and *in pace with the heart's systole*, but no such phenomenon manifests itself. The intestine in which we see the slow vermicular action owes this to the existence of *true* muscular fibre; but with the *diffusion* of this structure throughout the whole length of the organ, we mark the *absence* of an *alimentary heart* as a *special motor agent* in respect to the *intestinal contents.* Perhaps, then, we need no better proof of the *non-muscularity* of arteries in general than in the very fact of the existence of a *vascular heart*, fully adequate, as from the size and strength of its ventricles this organ appears to be, to serve as a *propeller of the blood* through the *arteries* as *passive conduits.*

The capillaries are the ultimate ramifications of the arteries and the primary radicles of the veins, terminating in, and continuous with, each other, in all parts of the body. Viewed under the microscope, they appear as delicate tubes, forming a network of such transparent material as to show the motion of the blood corpuscles in them; and, indeed, it is by this circumstance alone that we are enabled to distinguish them as *canals* from the tissue which surrounds them. In such extreme attenuation do the capillaries present themselves, that between them and nothingness there seems but a degree, and, therefore, to suppose them capable of exerting any *active* power in furthering the circulation from the arteries to the veins, and to believe in their "*muscularity*" so far as to attribute to it the "capillary power," would seem to leave nothing else for the microscope to reveal in regard to the universality of muscular agency, except it be the existence of muscular tissue in the *hyaloid membrane* enclosing the vitreous humour, and induce us to infer therefrom the perfectibility of the organ of vision. But that the capillaries cannot be in any way *active* in giving motion to the blood, may, I think, be well believed, not only from their actual visible condition, but from the structural analogy which must exist between them and the larger vessels of which they are the continuations. This, indeed, is confirmed by the fact, that the motion of the blood *per saltum* in the arteries by successive ventricular impulse, is scarcely perceptible in the capillaries, and the circulation in them is at a *minimum* degree of speed, and for this, without doubt, (because it *is* so,) there is a necessity, for we cannot conceive how rapidity of the blood should be otherwise than incompatible with the processes of growth and decay—deposition and absorption.

The veins are in structure the same as the arteries, but the former exhibit, if possible, a *non-muscularity* even less equivocal than the latter. In the veins, the middle coat does not show the fibrous character in any marked degree, and can serve little other purpose than as a medium of union between their lining and investing membranes. As, therefore, the veins are placed beyond the range of ventricular impulse, through the intervention of the capillary system between them and the arteries, and as they (by the evidence of structure) cannot have any *active* power of their own, it follows that they cannot serve any other office in the circulation than as *inert channels* for the returning blood.

From the facts now stated regarding the structure of the vascular system as it *exists*, the corollary deducible can be no other than this, viz., that *the arterial current is attributable to ventricular systole alone*, and that *the venous current being beyond the reach of that force, must be due to some power which the heart is not capable of exerting.* With this we at once close in upon the question;—to what agency is the venous current ascribable if not to ventricular, to arterial, to capillary, to venous, or to auricular? The negative evidence circumscribes and, as it were, enunciates the positive. If the venous current cannot be the effect of either cardiac or vascular action, it must be the effect of *thoracic*, and I proceed to prove anatomically that *the pericardium is a structure as essential to the circulatory apparatus as the pleura is to the respiratory.*

The thorax is so perfectly adapted to its contents, and these to each other, that together they represent *a mass without parted cleft or interval between them in any situation, either central or peripheral.* This fact it is necessary during the examination of each of its organs to keep always in view, for on it the thoracic-cardiac mechanism principally depends. When we would ascertain the full meaning of the thoracic economy, the enclosed organs and the enclosing parietes require to be examined as *a whole*, for, taken alone, the *eviscerated thorax* can as little express the signification of the machine of which it forms a part, as the case of a chronometer, or the cover of a book, can indicate the design of the work it receives. Anatomists, viewing the thorax in regard to its *osseo-muscular parietes*, usually describe it as a *single* apparatus, bounded above by the neck, below by the diaphragm, and laterally by the ribs, &c., and hence they omit to consider its *median plane* as being *parietal:* that it is so, however, and not only this, but that it plays an important part in the circulation of the blood, the anatomical facts seem to me to bear evidence. The thoracic parietes, by their osseous elements alone, do not enclose space completely. To see this condition we have to add to those parts the muscular. And once admitting a variety of elements as necessary to the construction of the thoracic form, we then are at liberty to include as many others as appear to determine the character of it in any way whatever. The form of the thorax may, therefore, be considered according to the disposition of its *membranous*, as well as

PL. XV.

Fig. 2.

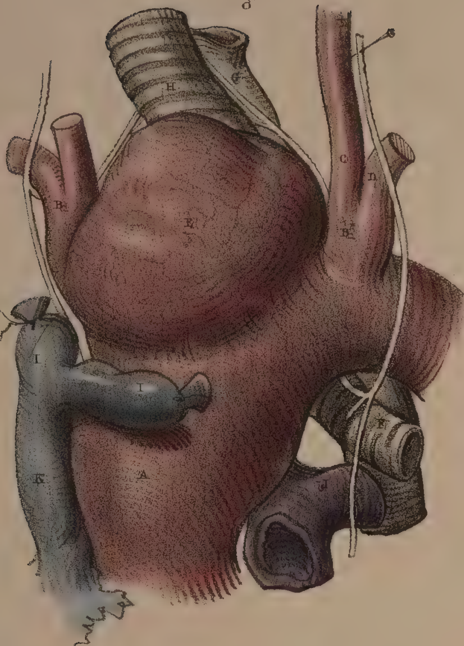


Fig. 3.

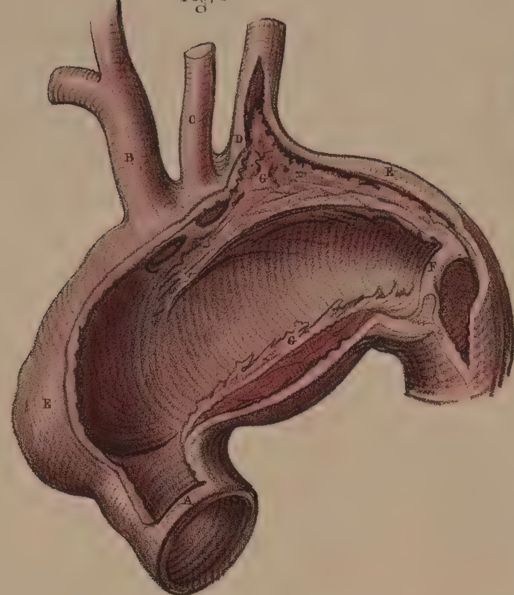


Fig. 4.

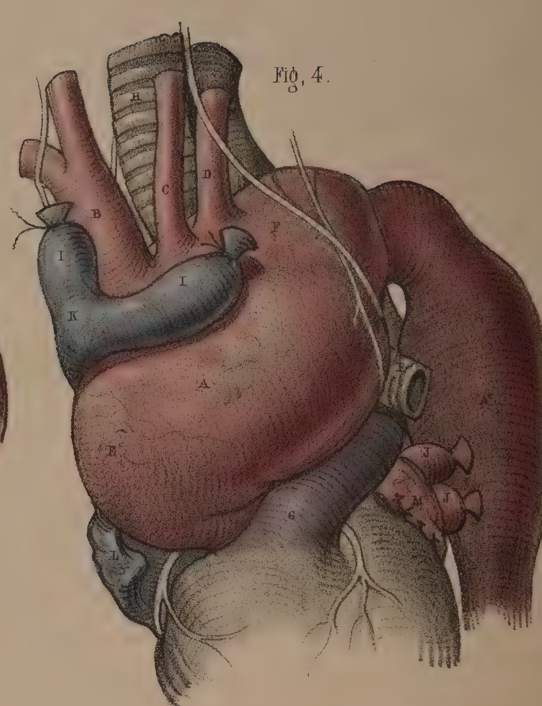


Fig. 5.

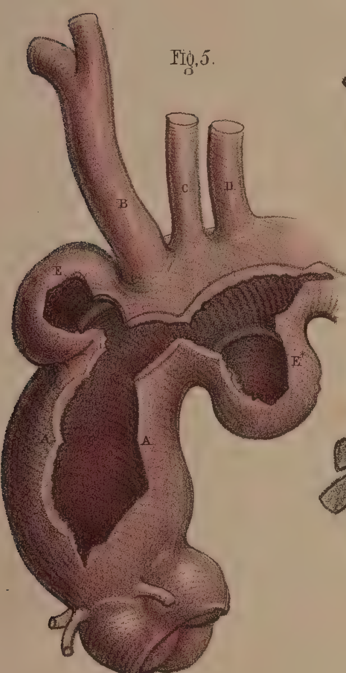


Fig. 1.

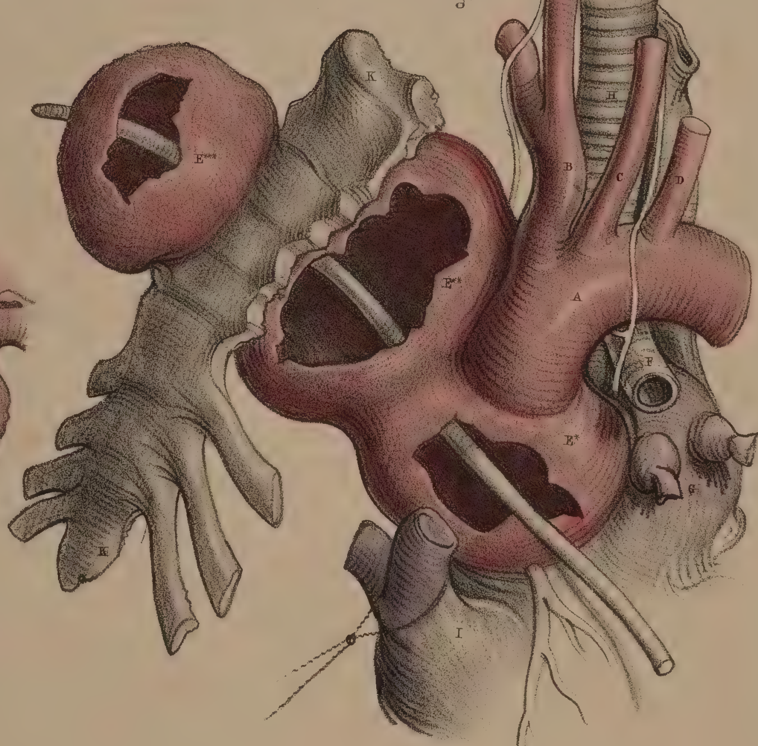


Fig. 6.

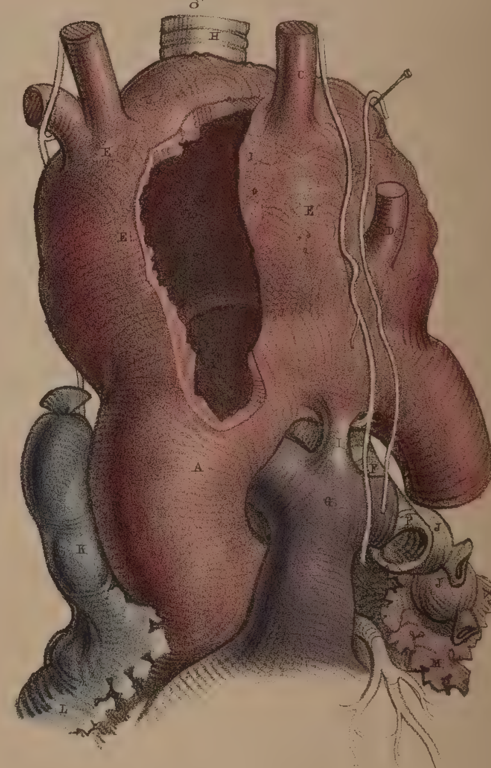


Fig. 10.

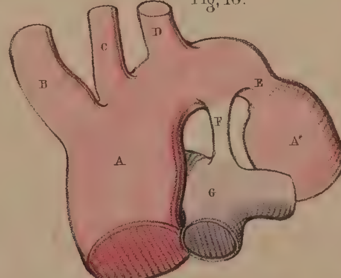


Fig. 7.

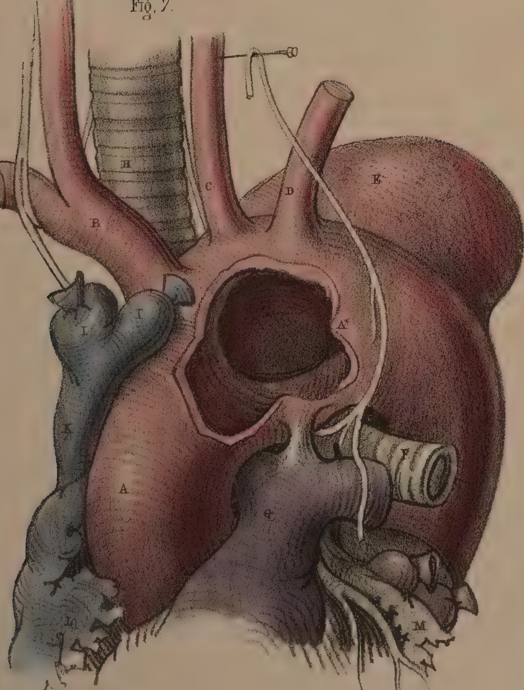


Fig. 8.

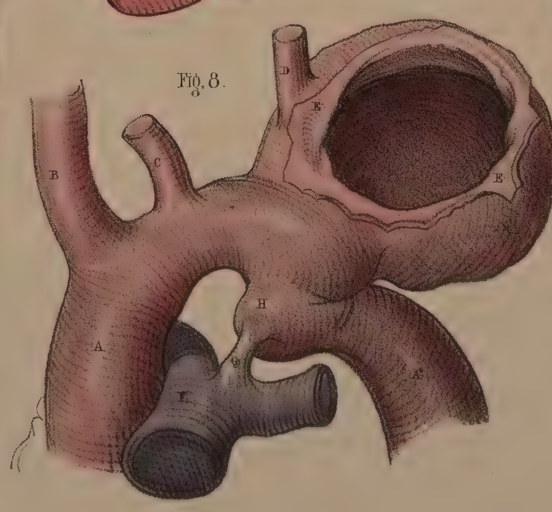
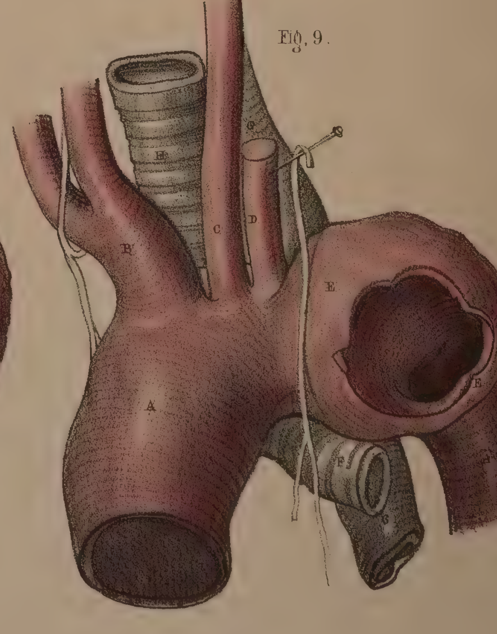


Fig. 9.



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that of its other parts, and by these I shall describe it, and show it to be a *double apparatus*, with *two apices*, *two bases*, and (taking both apparatus together) with *eight sides*, the *two adjacent sides being membranous-mediastinal.*

The thorax is naturally divided into *halves*, and each of these is so distinctly marked from the other, as to exhibit of itself a *complete chamber*, containing a *respiratory* and a *circulatory organ* of its own. If, in idea, we cleave the thorax from front to back through the *mediastinum* and through the *cardiac septum*, the resultant halves will contain each a lung and a heart, together with a complete pleural sac. To this perfect similitude of its halves and its lateral organs, its symmetry is due. But though by their union they constitute that entirety which we name the thorax, and act thereby in concertive motion, yet the fact of *duplicity* still holds so true, that, anatomically, the thorax consists of a right and left apparatus, and, as such, each must have its own *four* parietes bounding it *internally* as well as externally, anteriorly, and posteriorly. In illustration of this point, we have but to consider the form of the *mediastinum*, when we shall find that the very membranes (the *pleural sacs*) which constitute it, are those which represent the *inner or median sides of both pulmonary chambers*, and in this capacity they must be influenced by the general respiratory motions.

The mediastinum is the interpleural space at the thoracic centre. In it both the heart and lungs are contained. On tracing the two pleuræ from the costal sides to the sternal middle line, we find them here turning backwards, so as to face each other, and thereby to form the mediastinal septum. The two membranes come here into apposition at all points save where the viscera intervene. Where the viscera occur the membranes *attach* themselves to them and become their immediate investments. In this way the *right* side of the *pericardium* takes a covering from the *right mediastinal membrane*, while the *left* side of the *pericardium* is in the same manner covered by the *left membrane*, and thus, according to the size of the heart, both membranes diverge from the cardiac centre. Behind the pericardium, the roots of the two lungs (consisting respectively of the pulmonary vessels and bronchus) appear, and to *each* of these in like manner the mediastinal membrane of its own side is reflected, and the two separating thus *right* and *left* from the *centre*, and each forming a covering for the entire periphery of the lung are by those organs expanded into apposition with all parts of the *parietal* portions of the pleuræ, from the summit of the thorax to its base, and from side to side. Thus the pleural sacs become *collapsed* at all points by the lungs; and between the opposing *internal* surfaces of the sac of either side, that is to say, of that surface which is *pulmonary* and that which is *parietal*, no interval exists, or can exist, in the healthy state in the condition of *vacuum;* nor, indeed, in the diseased state either, for, when the two pleural surfaces are parted, the space must become occupied by something, either fluid, æriform, or solid. Such being a general view of the manner in which the parts combine for thoracic mechanism, the particular facts to which I would especially direct attention are these: 1*st*, as between the right and left pulmonary chambers there is no communication, and as each locates a distinct pulmono-pleural apparatus, so may the thorax be regarded as *duplex* in form, and each half having a *separate motionary function*, although we see both constituting a *symmetrical whole*, with sides acting in *concertive motion*. 2*nd*. The thorax consisting of a right and left complete apparatus, the *mediastinum* is hence to be regarded as representing the *inner side of each in contact*, while the *costal parietes* are the *outer sides of the two in union*. 3*rd*. Each lung assumes a form according to that of the thoracic chamber, right or left, in which it is situated. The extreme expansibility of the tissue of the lung enables it to do so as completely and subtilely as injected fluid. The lung diverges from the thoracic centre, where its pedicle appears, and from this it expands to a size equal to the area of its containing chamber. The form of that covering, therefore, which it takes from the *mediastinal* part of the pleura of its own side, must be struck according to the lung, and being, like the lung, *pedicled*, it follows that all the pulmonary pleura from this pedicle, around the whole periphery of the organ, comes into *sliding contact with all sides of the parietal pleura*, as well that side which the *mediastinum* represents as the three others.

The pericardium, which envelopes the heart in the thoracic centre, may be described as consisting of *three* layers of structures. The *outermost* of these three is that part of the *mediastinal pleura* which is in immediate relation to the heart. The *innermost* is the *serous membrane* which immediately invests the heart's substance. The *middle* is the *fibrous membrane*, and is the connecting medium between the two serous. The *fibrous pericardium* appears as a production of the cordiform tendon of the diaphragm, on which the heart rests, and from the circumference of which the membrane rises up about the heart, enclosing this organ on all sides, and becomes attached to the roots of the great bloodvessels. For each of these the *fibrous membrane* forms a funnel-shaped sheath, and is thence prolonged in the same manner over all the branches of those vessels as their *outer* tunics. Thus as the heart, by means of its vascular system, extends through all parts of the body, so does the fibrous pericardium by its vascular prolongations. The *innermost pericardium* is disposed in a very different manner to the other two. It is of the serous kind, however, like that of the mediastinal cardiac investment, but while this latter is reflected from the outer surface of the fibrous membrane to the lungs and thoracic parietes, the former, after lining the fibrous membrane, is reflected to the heart itself. On dividing the three membranes and exposing the heart, we view the glossy internal surface of the innermost one, and tracing this throughout its whole extent, we find it to be like all of its kind — a *shut sac* with a *visceral* and a *parietal* part. From this disposition of the serous lining pericardiac membrane, in respect to the heart and its chamber, it will be seen to bear a remarkably close analogy to that of the pleura in respect to the lung and thorax; and necessarily so, for in fact the forms of both owe their similarity to the circumstance that the organs they respectively envelope affect them in the same way. As the lungs placed between the two pleural sacs take their immediate coverings from the *mediastinal* or contiguous sides of these, and, expanding, carry those sides into universal contact with the *thoracic parietes*, thus forming *absolute pleural collapse*, so the heart, placed originally on the summit of the serous lining pericardium, becomes, in course of development, covered by the *adjacent portion* of that membrane, and pouches this portion into contact with all the *parietal parts of the pericardiac chamber*, and so creates *absolute pericardial collapse*. When we speak, therefore, of the *interior* of the pleura or of the pericardium, that expression can signify nothing more than *surfaces in general contact*—a state which, as to *included* space, represents *nihil*, and, like *vacuum*, is *uninhabited*, while the parts maintain their integrity. Hence, so long as this state obtains (as during life, when the whole thoracic viscera cohere in one mass,) it is not possible by any motion or effort to separate them from each other, and cause even the smallest interval between them; for the motion of one induces the same motion in the next, and so on throughout the whole. In whatever direction, therefore, the thoracic parietes move in respiration, the lungs, on the principle of pleural collapse, must obey, and as, on the same principle, the lungs cleave to the mediastinum, and this structure to the pericardium, and this to the heart, these must, at the same time, and in the same direction, obey the same motion. This is self-evident, and no less governable by the common law of motion than when, as now, I attach the *Principia* to the *Novum Organon*, and see the two volumes together obey the traction I exercise on either.

Now the *thoracic muscles* are the sole originators of respiratory motion,

FIGURES OF PLATE XV.

Figure I.—The aneurism, E,* is formed by dilatation of the root of the aorta, A, and projects through the thorax on the right side of the sternum, K.

Figure II.—The aneurism, E, is formed of the summit of the aortic arch, between a right and *left* innominate artery, BB.

Figure III.—The transverse part, EE, of the aortic arch is uniformly dilated; and at the posterior curve, a constriction, F, exists, which probably occasioned the dilatation.

Figure IV.—The aneurismal dilatation, EA, affects the aortic arch in its ascending, transverse, and descending parts.

Figure V.—Two aneurisms project from the aortic arch—one, E, from its superior curve, the other, E,* from its inferior curve.

Figure VI.—A large aneurism, E, formed of the summit of the aortic arch, involves the primary branches, ECD, compresses the trachea, H, and œsophagus backwards, and stretches the nerves on either side.

Figure VII.—The aneurism, E, projects from the back of the aortic arch, and displaces the trachea, H, to the right side.

Figure VIII.—A sacculated aneurism, EE, projects to the left side from the posterior curve of the aortic arch, and by its pressure gives this part, H, of the vessel an obstructing bend. The left subclavian, D, springs from the tumour.

Figure IX.—An aneurism, E, similar to Figure VIII., is formed of the front of the aorta, at its posterior curve, and compresses the left bronchus, F.

Figure X.—The aorta, EA,* is constricted at its posterior curve, so as almost to obliterate its canal.

and they affect the capacity of the thorax in all directions, from the middle line represented by the mediastinal plane. We find, however, that under their influence this result is principally manifested in *two* directions, namely, the *vertical* and the *transverse*, and this bespeaks a *traction*, not from one costal side to the other, nor from the episternal region downwards, but from the thoracic centre, *divergently* right and left, superiorly and inferiorly. The inspiratory motion indicates this fact, and the anatomy of the parts demonstrates it. The centre of a distended spherical sac is still, and from it dilating force tends in all directions to the periphery. When two such sacs are pressed side by side, those sides form the *middle* of the double figure. Let us now suppose those two sacs to be in a state of *complete collapse*, (the pleuræ) and two others *semi-distended* (the lungs) to be placed in side by side connexion between them, and from each of the two central ones a tube leading, and those tubes the branches of a common one opening externally, (the trachea and bronchi,) and all four enclosed in a larger sac (the thorax) in such a manner that between it and them no interval exists in any part, it will result that when traction is made on the sides of the thoracic sac the two *tubed* ones become fully distended, while the two *collapsed* ones still keep that state as previously. If, again, a fifth *collapsed* sac (the pericardium) be placed between the two inner ones, and be connected on either side with these, and traction be made as before, it will be found that the fifth, being now the sustaining centre against sundering force, does, rather than allow vacant space to occur in its interior, address itself to the lateral direction of that force, and not until it yields to its full limit can the *tubed* sacs become fully distended; for to those it is the fixed centre. Lastly, if a sixth *collapsed* sac (the heart) and *tubed* (venous) be enveloped by the fifth, and if the interior of the sixth be accessible to fluid (blood) by its tube, it will on traction being made as before, become distended by that fluid as forcibly as the bronchial sacs dilate by air. Such being a simplification of thoracic mechanism and its dynastic forces, we see how that the one motion may effect respiration and circulation at the same time.

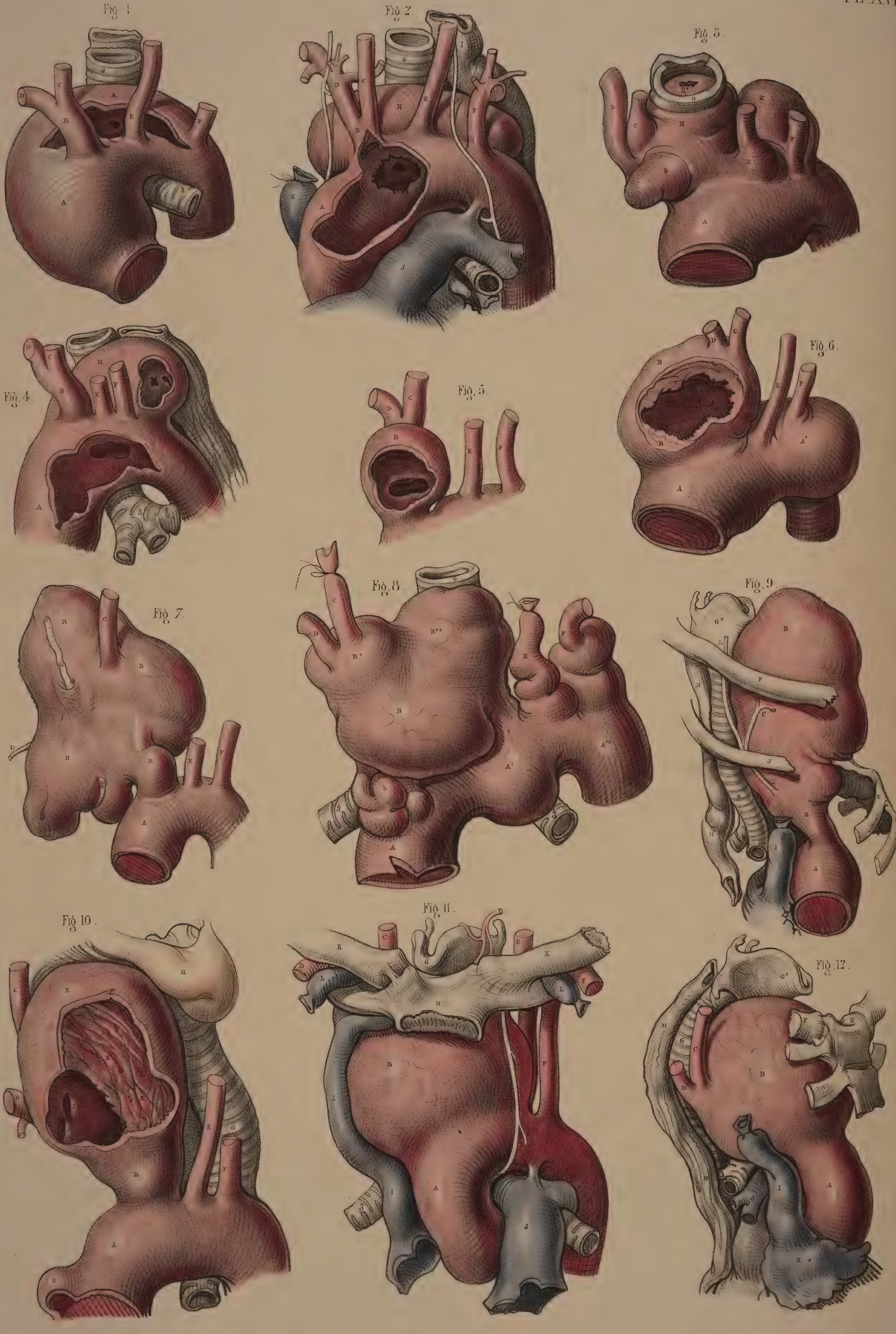
The *duplex* condition of the thoracic apparatus as a whole, being necessary to its action, we have thus expressed the signification of *duplicity*. The *right* and *left* thoracic machines, as *motor* powers, are placed *side by side*. Their sides in apposition between the episternal region and the middle of the diaphragm, form the mediastinum, or centre, from which both act. This centre is *membranous*, and hence capable of yielding to dilating force, originating in the external osseo-muscular sides. Between the mediastinal sides of the two machines, the *heart* and *great bloodvessels* are situated, rising from the diaphragm to the root of the neck. When both machines inspire, they threaten pleural collapse on their respective sides by a *lateral* traction from the mediastinal centre and a *downward* traction by the diaphragm; but the pleuræ maintaining their orginal state, the two lungs receiving the air through the tracheo-bronchial tubes, expand in the ratio of thoracic dilatation. As in this motion the increase of the thoracic area is altogether peripheral, so must pulmonary expansion be principally *centrifugal;* and this implies a forcible tendency of both lungs to *separate* from each other, and from the mediastinal centre. The bronchi enter the lungs at the facing (windward) sides of those organs; and though from this anatomical fact I do not infer (whether plausible or otherwise), a tendency in the two lungs to be blown apart from each other, it is certain that the *bronchial* character of their median sides, renders them here less expansile towards the centre, than *towards their costal sides*, next the source of motion; and hence that in the same degree as their costal sides follow the expanding thoracic walls, *their median sides* must obey the same motion from the central line outwards, and carry the mediastinal layers in the same direction. Now as we find those layers of the mediastinum to be in *structural connexion* with the pericardium and the great bloodvessels, it is therefore clear that whatever force tends *to sunder the mediastinum*, must also operate in the same way on the *pericardiac sides*. But as the pericardium cleaves to the heart on the same principle of collapse as the lungs cleave to the thoracic sides, *both mediastinal and costal*, by pleural collapse, it follows that since the pleuræ are *lateral*, and the pericardium *central*, and traction incapable of parting (so long as collapse is true and perfect) the one membrane from the other, or the sides of the same membrane from each other, the whole amount of force must concentrate on the heart itself, *as the hollow central organ*. It does so; and thus is effected the *diastole* of the heart, by agency of the respiratory muscles. A forcible diastole of the heart being the effect then of a forcible inspiration, I give the idea of thoracic mechanism, in the expression that, the pericardium enveloping the heart, is a circulatory machine within a respiratory one — *a thorax within a thorax.*

Having now examined the heart and vessels, and judged by the evidence of structure, which parts can be active and which parts cannot be; it may, I think, be very reasonably conceded that as the heart is incapable of maintaining the circulation throughout, and as the vessels are incapable of seconding the heart by any active power of their own, so no correct theory of the circulation can be established, unless we admit *thoracic agency as adjuvant to the heart*, and fully recognise that agency to be, if not more effective, certainly not less necessary than the heart to cause the phenomenon, as manifested in the *higher* classes of animals. The mechanism of the thorax, as I have now considered it, in reference to the heart, would alone lead us to that conclusion. And, accordingly, seeing the function reflected in the anatomy, I proceed to trace the circulation under this adopted view, namely, that *the blood is current in the arteries from the heart, by ventricular systole, as the sole propellant force*, and that *it is current in the veins to the heart, by thoracic dilatation, as the sole inductive force causing cardiac diastole.*

The blood being the only contents of the heart and vessels, may be said to traverse *vacuum*, as well throughout all parts of the body, as the lungs; and it is very much owing to this circumstance, that the circulating forces are effective. During life the *interiors* of the auricles and ventricles can never exist as *cavities*, for on the systole of those parts they become not only tenantless, but spaceless; and on their diastole, the blood immediately occupies them in exact proportion to their recipiency. Those facts may indeed be inferred from the states systole and diastole; for the former is but as *active collapse*, while the latter, is but as *passive relaxation*, which the entry of the blood itself changes to *distension*. In the vessels the blood is always present, and always motionary, without complete intermission; and this proves (what from any circumstance we are not inclined to doubt) that in no situation does a localised contraction occur on their part, so as to interrupt the continuity of their canals. In the *arteries* the blood is current *from* the heart, with an *impulsive* motion, corresponding with the successional ventricular systole; and the farther the vessel is from the heart, the less conspicuous that motion appears. In the *veins*, on the contrary, the motion of the blood is that of a *continuous*, uniform current; and the nearer the vessel approaches the heart, the quicker its blood moves *to* that organ; and the more evident it is that that motion is due to *respiratory action*—the blood rushing centrally, with increased impetus, on inspiration, and slackening speed, so as to cause turgescence of the vessels on expiration. When we tie a principal artery (the subclavian), we cut off from the ventricular influence the circulation through all the distal portion of the vessel; and yet this portion empties itself, as also the veins which hold capillary connexion with that artery. This cannot be the result of the *vis a tergo*, neither can it be the effect of the *vis a fronte*, considering that power as emanating from the heart, *per se;* for it could only occur by an *active diastole* on the part of the heart, which is an impossibility; and as to the so-called "capillary power," this is a mere nullity—a cause existing only in imagination. Hence, therefore, as the fact cannot result from any agency on the part of either heart or vessels, it can only be accounted for upon *thoracic motion effecting the diastole of the heart's cavities*, with a causative force sufficient to produce it; and this is expressed fully enough in the combined action of the *inspiratory muscles*, which the principle on which as I have shown thoracic mechanism is designed, allows them to exercise no less on the central heart than on the lateral lungs, closely embracing that organ by pleural and pericardiac collapse. A further illustration of this may be had in the fact, that when for a time, respiration is suspended, though the heart's action does not cease, the blood accumulates in the venous system and the right cavities of the heart, causing an obstruction which the heart itself is unable to overcome, and which returning respiration forthwith removes. That the circulating forces are thoracic, no less than cardiac, I find all general features of the vascular system affording corroborative proof.

The *arteries* are permanently cylindrical tubes, and traverse the body, *deeply seated*, sidelong with the bones, and sheathed by resistent fasciæ. In this position the coats of those vessels are doubtless in some degree removed from atmospheric pressure, which as the blood is current in them, *from* the heart, would but impede its passage; and hence the reason of their place. When at each systole of the ventricles, these impel their measures of blood into the aorta and pulmonary artery, an onward motion is given to the blood already in those vessels, even to their ultimate branches. At each diastole of the ventricles immediately succeeding their systole, the blood, reacted upon by the elasticity of the arteries, tends to re-enter the ventricles;

PL. XVI.



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but the semilunar valves at their orifices, now closing by the retroceding blood, prevent that occurrence. The succession of this *active* ventricular motion, and this *passive* arterial reaction, explains the *arterial pulsation.* The arterial pulse is always synchronous with the ventricular impulse; but the momentum of the vascular current, differing as it does in different places, proves that the heart's circulating force is subject to the common laws of motion: it is greatest at the cardiac centre, it weakens in the ratio of the distance from that centre, and consequently, it is weakest at the capillary periphery; where, in fact, pulsation becomes scarcely perceptible. This effect on a fluid moving like the arterial blood *in vacuo*, must be chiefly attributable to friction, and to the anatomical circumstance of the total area of the branches being greater than that of the common parent trunk. At the capillaries, the ventricular force may (for the slow pace of the blood shows the fact) be considered as about to cease; and here a new force, caused in no degree by cardiac *action*, commences.

In the *capillaries*, the motion of the blood has all the appearance of being *transitional*, by one force becoming spent, just when another commences to operate. In those vessels, the blood is of slow passage—meandering—labyrinthal: it is weakest in respect to the arterial current, and marks the expenditure of the ventricular *propulsive* force; and in respect to the venous current, it is also weakest as marking the first manifestation of the thoracic *inductive* force. This is precisely what we might expect from the form in which the vascular system is distributed. A single vessel (the aorta) issuing from the heart as the central agent of the arterial current, subdivides, successively, into countless ramifications remote from that centre; and from those subdivisions, an equal number of radicles arise, and by successive union of the many into the fewer, and of these into a single vein (the vena cava), ultimately terminate in the heart, just as the aorta originated in it. From this form of ramification of the arteries and veins, we *see* the result to be the slow motion of the blood in the capillaries, and this closes all argument on the supposition that the heart, whose only *action* is *systolic*, can effect the venous current. Unless, now, *thoracic influence* be admitted, we view in the venous circulation *an effect without a cause.*

The whole *venous* system, inclusive of the *auricles*, manifests, in its structure and allocation, a correspondence rather with *thoracic* than with *cardiac action.* The muscular force of the heart exercising no influence over the veins, the muscular power of the thorax and the pneumatic principle on which this apparatus is constructed, comes now into operation to effect the circulation through those vessels. The *veins* removed beyond the pale of ventricular force are (unlike the arteries which have to sustain that force) *thin, flaccid, inelastic tubes*, merely sufficient to serve as conduits of the blood current in them by force exerted *inductively*, which, therefore, cannot subject them to distending pressure. Unlike the arteries also, the *veins* are *collapsible*, and designedly so; for the better to allow of this effect by atmospheric pressure, they traverse the body, for the most part, *subcutaneously.* In the *veins* are found *valves*, formed by duplicatures of their lining membrane. In the arteries valves do not exist except at the cardiac roots of the common trunks, and here they are situated evidently in reference to the heart, as preventives of regurgitation. This expresses the use of the venous valves, and these themselves indicate not only the direction which the blood takes in those vessels, but that the power which moves it is alone *thoracic.* The blood moving in the veins from the periphery of the body to its centre, their valves prevent its retrocession, to which respiratory motion, so liable to interruption, would otherwise subject it; but as the arterial current is from the centre to the periphery, arterial valves would evidently not only be useless, but obstructive to its passage. All veins, except the *thoracic*, the *abdominal*, and the *encephalic*, possess valves, and it would appear that these are so conditioned in accordance with the places they respectively occupy. Considering the situations of the veins which are furnished with valves, we may infer therefrom their signification. The *valved veins* are those which are habitually (in man) *below* the level of the thoracic centre of inductive force, and hence their valves are evidently provisions for sustaining the venous blood against *gravitation.* The *cephalic veins* being *above* that level, and the *pulmonary veins* being *on* it, are not supplied with valves, for these would but obstruct the *gravitation* of their blood, which is directed by that force, not *from*, but *to*, the heart. The functional peculiarity of the portal system, as well as its position, is sufficient to account for the absence of veins in it. The veins are more numerous than the arteries, and of a greater total capacity than they. The veins, on that account, exhibit as well a *recipient* as a conductory office, and this circumstance of itself would show that the heart cannot exert through the arterial system a propulsive force to maintain the venous circulation, for currents in tubes (the arteries) of lesser caliber, however great their velocity and momentum, must lose, in both respects, on entering tubes (the veins) of greater caliber in proportion to the difference between the capacities of the tubes. In the veins the blood moves with less speed than in the arteries, and this may readily be accounted for, not only by the *greater capacity* of the veins, but by the *less frequency* of *thoracic inspiration* than cardiac systole. Whereas, if we were to suppose that the heart was the agent of the *inductive* force as well as the *propulsive*, the blood which it receives by the veins *should equal in velocity the blood which it distributes by the arteries, else there would occur a disparity between the quantities of issue and supply.* The great venous trunk is formed by the congregation of all its lesser branches, while the great arterial trunk forms all its own branches. This is typical of the circulating forces, and conformable to the distinction which I would draw between that which is *cardiac* and that which is *thoracic;* for as the arteries branch from the centre to the periphery of the body, so must the heart's systolic impulse weaken according to the increasing square of the distance from itself: and as the veins converge from the periphery to the centre, so must *thoracic induction strengthen according to the decreasing square of the proximity to the thoracic centre.* The phenomenon of the circulation perfectly exemplifies this rule, but while it does so, the heart itself (having but one *action-systole*, and the force of this action becoming spent on the arterial semicircle) proves that it can play no more active part in reference to the venous circulation than if it were as motionless and dead—as Harvey's.

The *theory of the circulation* being inexplicable on the heart's action alone, we must then look for an assistant action in the thorax, and the mechanism of this apparatus answers our wants completely. The heart, situated at the thoracic centre, and enveloped by the collapsed pericardium, this, by the mediastinal sides of the collapsed pleural sacs, and these sides by the *enwrapped* lungs, is by this means brought under the influence of motion originating in the thoracic parietes. The thorax inspires and dilates in all directions, but chiefly *laterally* and *abdominally*, from the *centre*, and *pari passu* with that motion, the opposite lungs expanding, *diverge* from that centre, while the diaphragm *descends* with the lungs, at the same time following it. By the inspiratory act, the two lungs *retract* the mediastinal membranes from each other and from

FIGURES OF PLATE XVI.

Figure I.—The back of the arch of the aorta, A, is aneurismal, and has ruptured by a small orifice into the trachea, G.

Figure II.—An abrupt aneurism, H, projects from the back of the transverse part of the aortic arch, behind the branches, B E F, and has ruptured into the trachea, G.

Figure III.—An irregular aneurismal dilatation, B H E, formed of the summit of the aortic arch, involves the primary branches, and has ruptured into the trachea, G.

Figure IV.—The aneurism, H, springs from the summit of the aortic arch, behind the primary branches, B E F, compresses the trachea, displaces the œsophagus to the left side, and opens into this tube by two small orifices.

Figure V.—The innominate artery, B C D, is dilated in the form of a small rounded aneurism.

Figure VI.—The innominate artery, B B D C, is aneurismal on its right side, and the tumour includes a portion of the summit of the aorta.

Figure VII.—The innominate artery, B B B, is dilated into a large irregular aneurism. The carotid branch, C, appears springing from the upper forepart of the tumour. The subclavian branch, D, is degenerated to a mere cord, and quite impervious. The vagus nerve is embedded in the anterior wall of the tumour.

Figure VIII.—The three primary branches, B E F, and the aortic arch itself, A A, are aneurismal. The innominate, B, is largely dilated, and compresses the trachea, G.

Figure IX.—The innominate artery forms a large aneurism, B, which has dislocated the sternum, E, from the clavicle, F, and upper rib J, and projects upwards in the neck to a level with the thyroid cartilage, G. Its carotid and subclavian branches, D C, are degenerated to mere cords. The trachea, G, and œsophagus, H, are pressed against the vertebræ.

Figure X.—The innominate artery, B, is dilated to a large fusiform aneurism, projecting from its bifurcation upwards to a level with the larynx, and displacing the trachea and œsophagus to the left side. The aneurism contains a thick coagulum, K, which is hollow opposite the orifices, I J, of the branches of the vessel, which are still perforate.

Figure XI.—The innominate artery, B, is largely dilated, and so distorts the parts, that the thyroid cartilage, G, is drawn down to a level with the sternum, H; and the vena cava, I, vagi and phrenic nerves, and left primary branches, E F, are stretched much beyond their ordinary length, owing to the depression of the heart.

Figure XII. — The innominate artery, B is aneurismal in a form similar to Figure XI.

the middle line in the same way, and on the same principle as the thoracic outer sides retract the lungs; and as the mediastinal membranes form respectively a *lateral* investment for the pericardium, and are structurally connected with this part, they carry it with them, *widening it towards either side from the cardiac septal centre.* While the lungs are acting on the pericardium *laterally*, the diaphragm is stretching it *downwards*, towards the hypochondria, and by these *opposing actions* the capsule of the heart is rendered *tense.* Now, as the pericardium cleaves to the heart on the principle of *collapse*, just as the lungs do to the thorax, we may well conclude that the force which tends to *withdraw* the pericardium from the heart, and create *vacuum* within it, will, in failure of this event, operate on the heart itself, and, as a *hollow* organ, *dilate it.* This *dilatation* is the heart's *diastole*, but evidently it is not the *act* of this organ, but of the thorax; and as the *venous* current cannot be else accounted for, it must be wholly dependent upon this act. The auricles are comparatively thin in their walls, and are therefore the more readily impressionable to dilating force operating on the pericardium. The right and left hearts *in union* have respectively the lung on their own sides to dilate them, and this effect could only be attained by the two lungs acting *against* each other, with the heart *between* them as the centre from which their traction tends in opposite directions. As, therefore, the whole cardiac apparatus of ventricles, auricles, and vessels, occupy the same central plane between the mediastinal layers from the root of the neck to the diaphragm, and as, for this extent, the opposite lungs embrace them with free sliding serous surfaces intervening, so all parts of that apparatus become equally and synchronously influenced by the *dilative traction of the lungs.* From this evidence of the heart being systolic of its own act, and diastolic by that of the pulmonary apparatus, I turn to examine the *mutuality* of both as *circulating organs*, and I find this to be such as supports the present views in all respects.

The two lungs are (during life) always in a state of distension, from residual air occupying their vesicles even after extreme expiration. In this state their distension is *constantly* of about two thirds of what they are capable in full inspiration. Between the extreme limits of thoracic motion, therefore, the distension of the lungs varies only like *plus* and *minus* from that in which they permanently exist to that which they assume in full degree. Thus, as *inspiration* and *expiration*, in respect to the lungs, express not the variation between absolute repletion and absolute emptiness, but between the *whole sum* and *the lesser*, so may those organs be considered as exercising a *constant traction from the cardiac centre laterally*, which is but increased on complete inspiration. Hence is it that in all states of the thoracic parietes, the opposite lungs cleave to those parts with equal tenacity, and hence also the endurance of their centrifugal tendency, whether the thorax be passive or active. The *venous current* gives indication of its being governed by this motion, communicated from the thorax to the heart through the medium of the lungs. *The constant traction* of the lungs explains the *permanence* of the venous current; their *inspiratory traction* its *increased rapidity;* and their *expiratory retrocession* the *venous regurgitation or pulsation.* In this enduring tendency of the lungs from the thoracic centre we recognise a force ever acting to promote the diastole of the heart; and in the systole of this organ we recognise a force intermittently counteracting the other. While the lungs *diverge*, and, through the intervention of the pericardium in collapse, act upon the heart laterally, this organ being in repose, they dilate its cavities, and threaten them with *vacuum*, but instantaneously with the motion the blood enters them, and the advance of it here is the return of it from all the venous system, even to their ultimate radicles—the capillaries. The *diastolic tendency* then being rendered (by the more or less constantly expanded lungs,) *permanent*, though never of such strength as to hinder the *heart's systole* at the moment this is required, we see how both motions may occur in rhythmical succession without the thoracic motions timing with them, for between a force (the diastolic) which can be assumed as *ever* in exercise, by means of the lungs, and an opposing force (the systolic), which, by the heart's own action, is in operation only interruptedly, I maintain that an agreement must manifest itself in respect to the object of both—namely, the circulating blood. The want of correspondence, therefore, which appears in the *relative frequency*, at any time, of the *respiratory* and the *cardiac motions*, cannot be an objection to the present theory, which assigns to the lungs and the heart *equal parts in maintaining the circulation;* for no sooner is the *heart relaxed in repose*, as it is in the interval between its *systolic* actions, than the lungs, perpetually manifesting centrifugal force, convert the relaxation of the heart into the diastolic state, and, thereby threatening vacuum in its cavities, cause a movement of the blood to occupy the void. If now we will revert once more to the consideration of the main anatomical fact upon which I found, and according to which I would lead, the foregoing observations to their purpose—the fact, namely, of a *duplex heart in a pericardium, and located centrally within a duplex respiratory apparatus*, we shall see how the circulation of the blood cannot be effected, unless by the combined action of both, and how the actions of the two correlate for this result.

As the right heart has the right lung applied to it, and the left heart the left lung; and as the heart, as a whole duplex organ, stands *midway* between the two lungs, and must therefore be influenced by these in all its parts at the *one* time, we should expect the diastole of all the heart's cavities to *occur together at that time;* and if this be the case, so may it be inferred that the systole of those cavities subsequently take place *together* in like manner. In this simple order I can, of my own observation, assert that the motions of the heart actually happen. On viewing the heart as it moves in the open thorax of an animal not yet dead, I notice that, after the systole of the auricles, that of the ventricles succeeds so instantaneously, as to make both motions almost *one in time*, and the four parts almost *one in act.* After their action, the four parts of which the heart is formed lie in *passive relaxation;* and as this is the state which is necessary to diastole, it must be then that the latter phenomenon occurs in the living body; and (because there is no anatomical condition to hinder it,) the four cavities may then be replenished at the same period. While the auricles and ventricles are passive, and are being dilated together, the auriculo-ventricular valves are relaxed, and the cavities of both parts are alike accessible to the blood. When the auricles are replete they contract, and complete the measure of the ventricles, and these, then, with a quickness leaving no interval, perform their *systole*, and by that very motion on their contents, close the *auricular valves* and part the arterial, when the blood issues from them now together into the lungs by the pulmonary artery, and through the body generally by the aorta, the heart receiving, immediately after its action, the ever-returning currents of the pulmonary and systemic veins. Thus, then, with a *pulmonary action* in constancy effecting the heart's *diastole* as to all its parts at one period, and with a *cardiac action* intermittingly effecting the heart's *systole*, is illustrated the reciprocity of the thorax and the heart as agents for the circulation of the blood by inductive and propulsive forces. And as capable of enlinking those agents to this effect, I have described the pericardium, and assigned to it a purpose which it appears to me is as real as it is new to anatomical science.*

In death, as in life, the phenomena give evidence that the circulation of the blood depends no less upon thoracic than upon cardiac action: a gasp is the first requirement of the new-born—a succession of them is respiration, and this marks its life throughout—a gasp is its last dying act. By a gasp the heart is relieved of its oppression; and after death it is found, as a consequence of the last inspiration (which causes cardiac diastole), that the venous system, with the compartments of the right heart, are gorged—the heart itself having ceased its systole, and severed the bond of partnership.

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* If these views happen to fall within the notice of any physiologist, and he, glancing lightly over them, sets them aside as a mere revival of the doctrines of Sir David Barry and Dr. Carson combined, and as long since ably argued on all sides, and overthrown by the reasoning of Dr. Arnott (*Elements of Physics*) and the learned author of the article "Circulation" (*Cyclopædia of Anatomy and Physiology*), I would beg to acquaint him that before I read those works I had, from the unaided study of the mechanism of the thorax, as indeed the facts I have adduced must show, arrived at the opinion enunciated in the text. Moreover, after having perused those works, I see no reason strong enough to make me abandon my opinion. I mention this not with the object of laying claim to originality (for such claim, even if conceded, would be to me but as a bubble compared with the satisfaction I feel in seeing truth demonstrated, no matter by whom) but to show how a subject of this kind obtrudes itself upon us as thinkers, though separated as to time, place, and circumstance. Any doctrine which admits of being equally argued *pro* and *contra*, leads me to believe that the truth rests *midway* in it; and from this point, as from the fulcrum of a balance, the force of argument will sway it up or down. Are we not prone to be deceived, in the search after truth, by our very senses? Did not the *Ptolemaic system* govern the reasoning world even long after the *Copernican* was advanced? A doctrine, like an animal, will still manifest the life that is in it through the folds of its vestments, however closely we cover it. When I assign to thoracic and to cardiac action *equal* parts, in effecting the circulation of the blood, and another, on opening a vein, says, Lo! how untenable your doctrine is; how can your thoracic induction be that force which causes the blood to issue from the distal end of the vessel? I, in turn, ligature an artery, and say, Behold! how else will you account for the distal part of this vessel, and the veins in capillary continuation with it, becoming empty, when I have arrested, in respect to them, the heart's systolic action? In the same manner, and with equal force, may all argument in support of the one view be opposed by contrary argument in maintaining the other; and in the contention, as I imagine, we cleave the truth in halves. At all events, and urging into notice for the present only the function which I have assigned to the structure *pericardium*, that function will, I dare hope, be acknowledged by the descriptive anatomist as a move nearer to the goal of truth than what he would have us rest content with in the idea expressed by the etymology (περι, κηρ,) of that name, which, in reality, though it be Greek, implies no more the use of the thing than when the dissecting-room Charon, to supply its place, wraps the heart in a wet rag and walks off, with bruising heels, heedless of us, though we cry, "Stop! for your tread is on Immortal's dust.'"

Fig. 1.

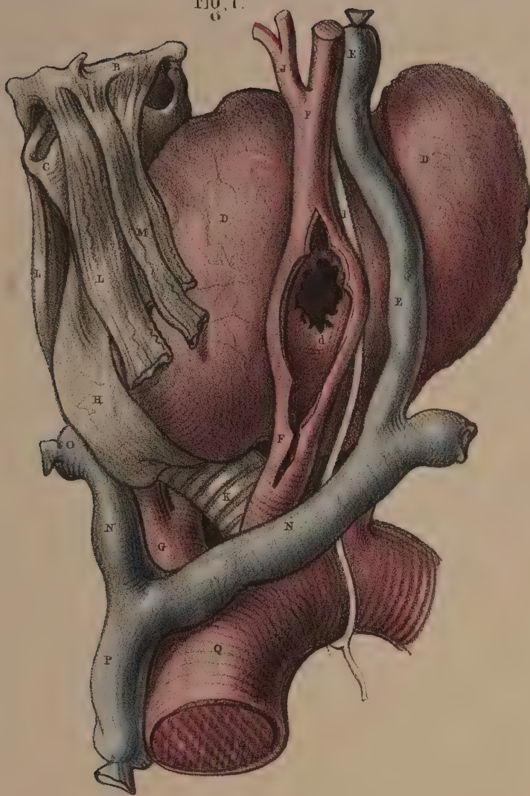


Fig. 2.

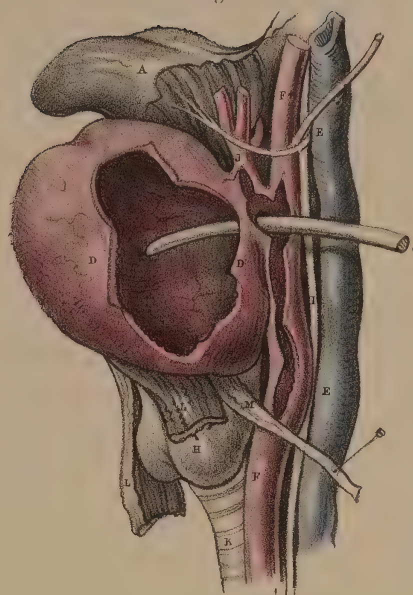


Fig. 3.

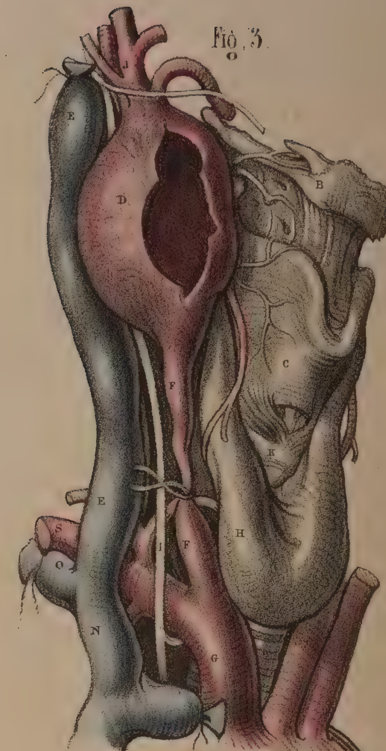


Fig. 4.

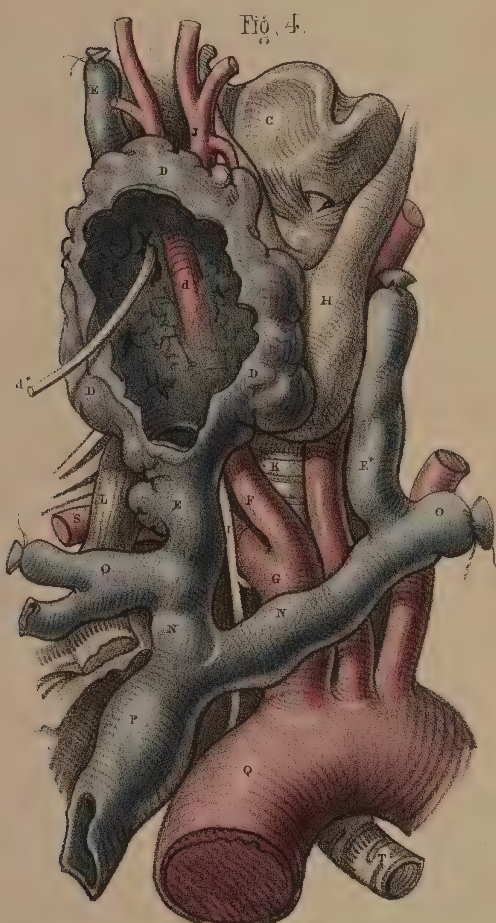


Fig. 5.

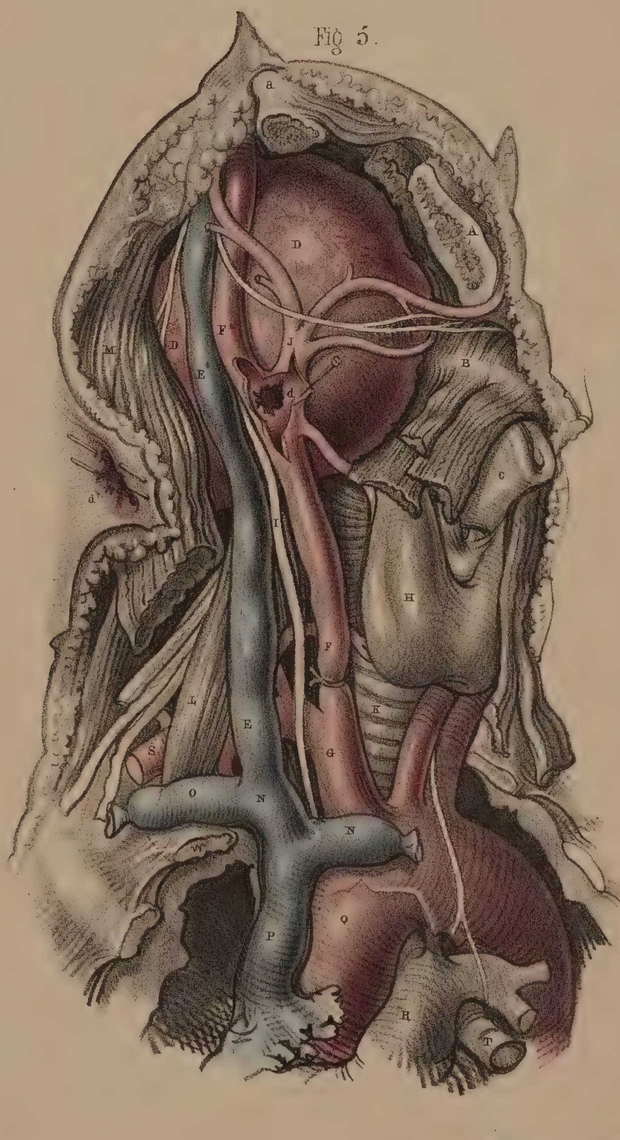


Fig. 6.

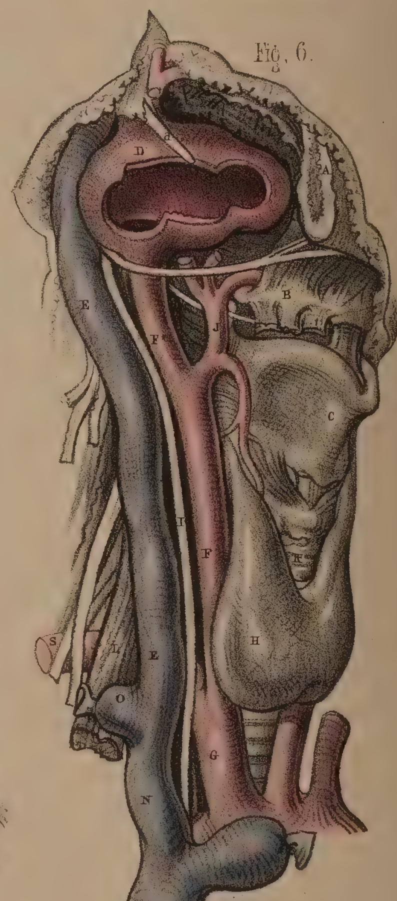


Fig. 10.

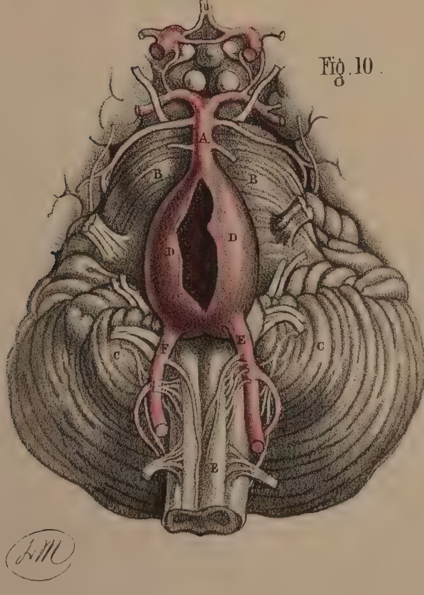


Fig. 9.

Fig. 8.

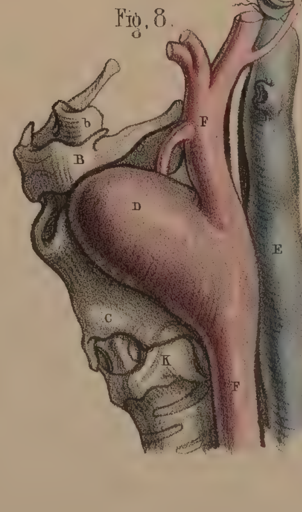
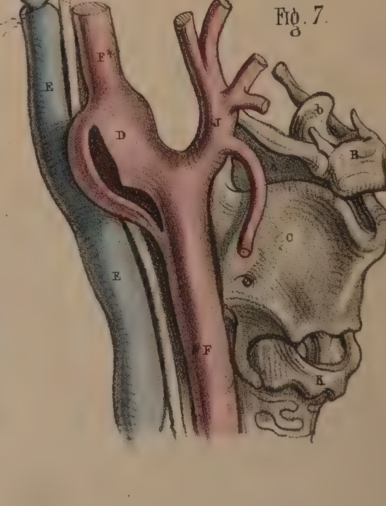


Fig. 7.



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COMMENTARY ON PLATES XVII. & XVIII.

ANEURISM OF THE CAROTID, SUBCLAVIAN, AXILLARY, AND BRACHIAL ARTERIES. JUGULAR AND BRACHIAL ANEURISMAL VARIX. THEIR CAUSES, FORM, EFFECTS, SYMPTOMS, AND TREATMENT EXPLAINED ACCORDING TO THE CIRCULATING FORCES.

If we consider aneurisms of arteries and varicosities of veins in reference to the forces of the cardiac-arterial and thoracic-venous *double* circulatory apparatus, we shall find those diseases to illustrate those forces in every particular. An artery is the only vessel which can be affected with aneurism, because that vessel alone receives the impulse of the left ventricle of the heart through the medium of the blood; and, when once its coats yield, its form is the indication, and its progressive increase is the effect, of the repetition of that impulse. A vein, although being similar in structure to an artery, and for that reason equally prone to the same kind of degeneration of tissue, is nevertheless not subject to aneurismal dilatation, and therefore the cause of the vein's immunity from the disease is to be attributed to the circumstance of this vessel being removed from the influence of the heart's action. But when a principal artery opens a direct communication with a principal vein, the latter vessel then becomes at once dilated in aneurismal form; and thus in the pathological condition nature herself indicates plainly enough the distinction between the cardiac *impulsive* and the thoracic *inductive* forces. For, assuming the venous current to be dependent upon the heart's action through the arterial system, how can that action promote that current, when, instead of operating through the capillary field, its force, as in the case now instanced, is diverted through the hiatus of the artery into the vein, and in the latter vessel opposes a current nevertheless still existing?

When veins having no communication with the arterial system, except by the capillary channels, suffer dilatation, the cause of that state appears very different from that which induces aneurism. No part of an artery becomes aneurismal, notwithstanding its tunics may be diseased, if between it and the left ventricle the main channel be obstructed even partially; and when the aneurism already exists, the obstruction promotes its cure by arresting the heart's action on it. This proves as well that the heart's inordinate force is the prime cause of the disease, as that the arterial current from the heart outwards is due to the ventricular systole of that organ. On the contrary, no part of a vein can become varicose unless between it and the thorax the impediment to its current occurs, and the persistence of this impediment establishes the disease. This fact, in connexion with those already adduced, proves not only that the course of the venous blood is from the periphery of the body to the heart, but that to the action of that organ the varicosity is in nowise directly due; but those facts do not at all militate against the present doctrine, which assigns the venous circulation mainly to thoracic induction. The vein then being thus *naturally* isolated from cardiac action, and *accidentally* from full thoracic influence, we must attribute its varicose state to some other cause. The form of the varicosity indicates this cause; and so likewise does the situation of those veins which are generally the subjects of it. The veins of the *lower* extremities and those of the *pendent* testicles, are of all others the most liable to the varicose state; and the form which that state presents expresses the passive fall of the blood in obedience to the now dominant force of gravitation.

In marked contrast with the form assumed by the varicose vein, we find that of aneurism of an artery. The latter, wherever situated, exhibits features explicable according to the ventricular systole alone; and this is further illustrated in the greater frequency of aneurism of the aorta than of the pulmonary artery. In no one instance (as far as I have ascertained) has the pulmonary artery been *primarily* the subject of aneurism; and this is the more remarkable, seeing as we do that between that vessel and the aorta there is not the slightest difference as to structure in their normal state, and hence that no reason can be assigned why the one should be degenerate in tissue oftener than the other. On comparing the two ventricles, however, we see the right to be much less powerful than the left; and when we add to this the natural difference in the form of both vessels, and the difference as to the structure and situation of the parts in which they ramify, the cause of the pulmonary artery being so exempt from the disease must attach to those circumstances. With regard to the aortic system of arteries, again, experience shows that, as a general rule, the nearer to and the farther from the left ventricle the artery is, the more frequently in the former place, and the less so in the latter is it liable to become the subject of aneurism. As all the aortic arteries are the same in structure, and equally prone to the same kind of degeneration of tissue, we must, on failing to find in this a cause why the disease should occur in one place oftener than in another, assign that circumstance to the varying force of ventricular action. We do not find the arteries of the hands or feet at all prone to aneurism; for they are remotest from the heart; whereas, thoracic aneurisms of the aorta so near the heart are very common. But while to the proximity of the aorta to the left ventricle may thus reasonably be assigned the frequency of thoracic aneurism, this fact, it would appear, is in no small degree attributable also to the form of that vessel itself. In man the arch of the aorta is more marked than in the lower animals, and this may per-

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FIGURES OF PLATE XVII.

Figure I.—An aneurism of very large size, D D, is dilated from the inner side of the left common carotid artery, F F, and displaces the trachea, K, and other parts, to the right side. The vagus nerve, I, and internal jugular vein, E, are stretched over the outer side of the tumour. The walls of the aneurism cannot be said in this case, or those represented in figures 2 and 5, to be formed of so small a part of the vessel as that now described by the dimensions of the aneurismal opening, *d*, and therefore they must have been formed by the fascia and cellular substance.

Figure II.—An aneurism, D D, springs from the fore part of the left external carotid, J, and displaces the tongue, A, and larynx to the right side. A bougie, *d*, marks the aneurismal opening.

Figure III.—The upper part of the right common carotid, F, is dilated uniformly into a rounded aneurism, D, which compresses the jugular vein, E, and vagus nerve, I. The vessel below the aneurism shows the state it assumes after being tied.

Figure IV.—An aneurismal varix, D D, is formed between the right jugular vein, E, and the right common carotid artery, F. A small bougie, *d** is, passed into the channel of communication.

Figure V.—The right common carotid artery, F, at its bifurcation, F* J, forms a large globular aneurism, D D, on the inner side of the lower maxilla, A a, and reaches to the base of the skull. The larynx and pharynx are compressed to the left side; the sterno-mastoid, M, is forced backwards; the internal jugular vein, E, vagus, I, and other nerves, and also the artery itself, are stretched on the outer side of the tumour. This is the case, which, judging from the age of the patient, (11 years,) his being convalescent after fever, the shape of the swelling and the pulsation being obscure, and such as a tumour next the carotid artery might manifest, was mistaken for an abscess (which it may have been originally) by the late Mr. Liston, and opened by him behind the sterno-mastoid muscle at the point *d*.

Figure VI.—An aneurism, D, is formed by dilatation of all the coats of the right internal carotid artery, F*, and projects forwards between the lower jaw and tongue.

Figure VII.—An aneurism, D, of the root of the right internal carotid, F*, in its first stage.

Figure VIII.—An aneurism, D, of the upper part of the left common carotid, F, in its second stage, and projecting forwards aside of the larynx, B C K.

Figure IX.—An aneurism, D, of the internal carotid artery, seated on the body of the sphenoid bone.

Figure X.—An aneurism of the basilar artery, beneath the pons Varolii and medulla oblongata.

haps explain the rarity of the disease in the latter. The erect posture necessitates the pendent position of the human heart, and consequently the abrupt curve of the aorta. This form of the vessel (though certainly under the circumstances the most fitting) is not the most favourable to the free passage of the blood from the ventricle. At every systole of the ventricle the blood jetted from it in a direct column, tends to straighten the aortic curve, and failing in this, reacts on the heart itself and lifts it from its seat. The apex of the heart tells this motion in succession against the left side of the thorax, and the pulsation may be regarded as a *nisus* of the organ to overcome the certain amount of impediment which the curve of the aorta occasions to the blood passing through it.

The passage of the blood through the aorta is obedient to the same laws of motion which govern the transmission of currents through other tubes of similar form and properties, and under similar circumstances. While fluid is impelled, *in vacuo*, through a tube whose outer surface is removed from atmospheric pressure, (as the aorta is during both states of the thorax, and especially that of inspiration,) the momentum of the current is always in the ratio of the caliber of the tube and of the proximity to the prime mover. This obtains when the tube is straight and of equal caliber throughout. But if the tube be *abruptly curved* in any part, the momentum of a current passing through it will be abated still more by the curve; for as fluid, like other bodies acted upon by a *single impulse*, moves in *a direct line* from the actor, the *first portion* of the curve which opposes it, and causes it to assume a new direction, must occasion an expenditure of force according to the degree of the curve; and therefore the force of the current is weakened beyond such point. Applying this to the aorta, we can understand why the *anterior curve* of its arch having *first* to sustain, to curb the momentum, and to alter the course of, the blood impelled through it by ventricular systole, should oftener become aneurismal than the *posterior curve*, which is *more distant* and receives a current of *weakened impetus*. Though both parts be equally disorganized, it is the forepart which necessarily will first yield.

The *normal* form of the aortic arch is itself expressive of the manner in which ventricular action affects it. The forepart represents a *sinus*, evidently to receive the measure of blood jetted into it, and momentarily hindered from its direct onward course by the curve. The sinus, therefore, may be considered as the natural result of distending force; and, as such, we find it more or less conspicuous, according to the state of the ventricle which affects it. If the ventricle be hypertrophied, so as to increase its power and capacity, the aortic sinus becomes proportionately enlarged. When, as in *infancy*, the ventricle is relatively small and weak, the sinus is then scarcely distinguishable from the other parts of the arch. In *adult age* the sinus is indicative of the force of the heart, and this of the development of the muscular parts in general. In *old age* we find the sinus ordinarily very capacious; but this feature, and the tortuosity of the vascular system throughout, appear more justly ascribable to the *atonic relaxation* which affects all tissues of the body at this period, than to inordinate cardiac action. In fact, while a *true aneurism* is defined as a *dilatation of all the arterial tunics*, the *aortic sinus*, as being the *effect of distension*, may be considered *naturally aneurismal;* and, except in extreme cases, it is difficult to pronounce which is the abnormal and which the normal condition. An *abrupt pouching* of the aortic arch is an irregularity at once pronouncing its true character; but the "uniform dilatation" being natural in some degree, the excess, within certain limits, and provided the coats of the vessel be unaltered, and the semilunar valves capable of just closure, may exist, and no untoward effect be manifested.

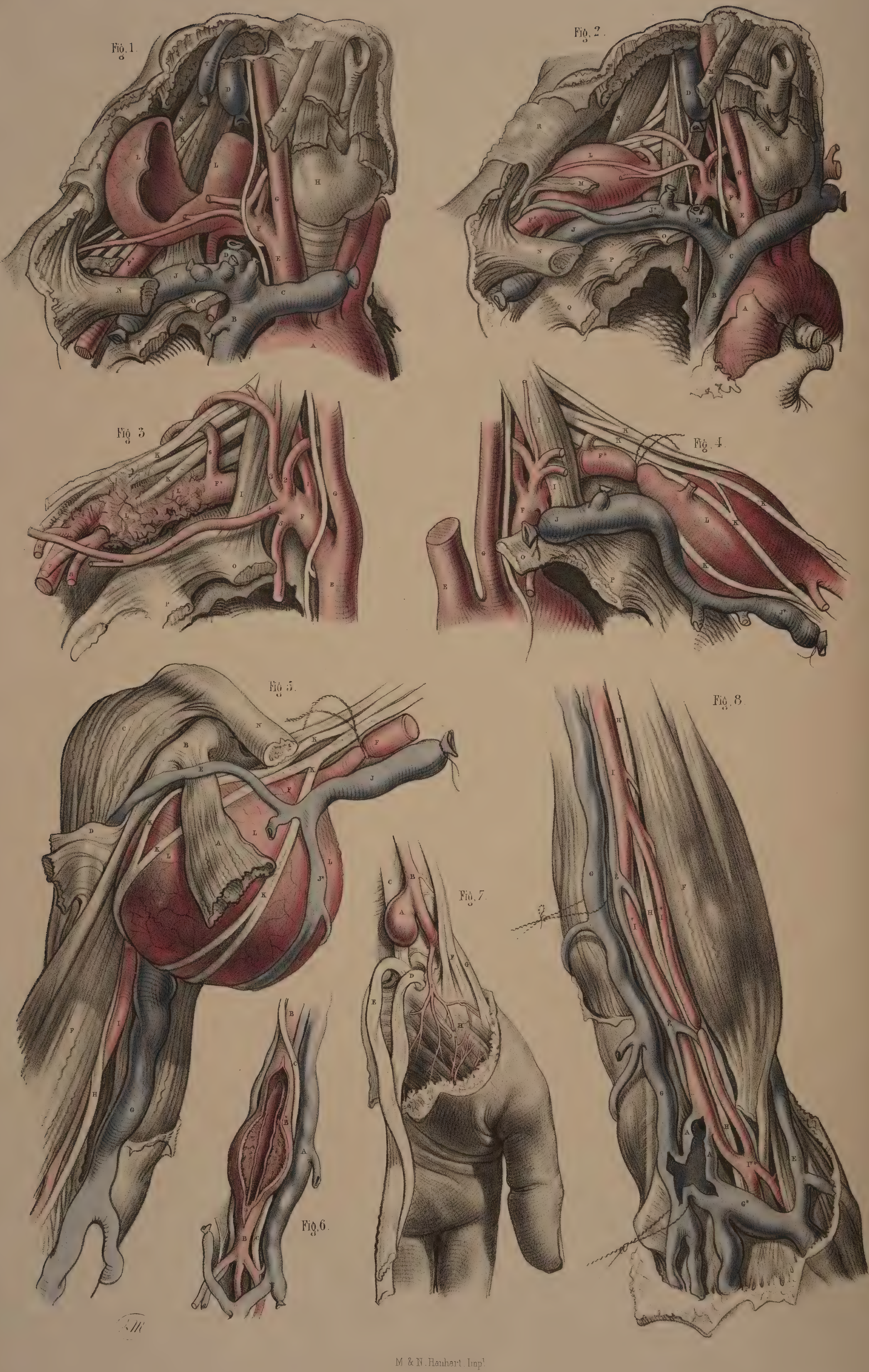
The primary branches must serve in no small degree to modify the force of the current of blood passing through the aortic arch. In the number, form, and position of those vessels, there appears to me to be a marked design for effecting that special object. They spring from the *summit* of the arch where the *centrifugal force of the current is strongest*, and while as *vents* for the blood they obviate the inordinate distension to which this part (were they absent) would be subjected, they can here receive and convey the quickest of the blood to the brain, and maintain the circulation in that organ the more effectually against the force of gravitation which operates on all the fluids of the body, vascular as well as visceral. In their *serial order* and *respective size*, this design is further indicated. The *innominate*, the largest branch of the three, is generally the *first to arise*, and as it corresponds with the point where the arch receives the heart's full impulse, it prevents that force taking effect on the aortic tunics, in proportion to the quantity of blood to which it gives direct passage. Next in order, the left carotid and subclavian branches arise *distinctly* from the arch; and this also expresses its meaning, for the ventricular force being in a great measure expended on the large innominate, and the *momentum* of the current becoming in consequence weakened beyond the origin of that branch, the two others, which are respectively of *smaller caliber*, give to their currents *velocity* in lieu of *momentum*, and thus equalize the difference in respect to the brain. This change from momentum to velocity occurs also to the aortic current, where the aorta, after giving off those branches, is itself diminished in caliber. Such is the law governing the transit of a fluid through a tube, whose caliber is greater nearest the motor power than it is at a more distant part. And as the entire arterial system shows every branch of it to be of this form, so those branches, collectively and individually, are in the same way influenced by that law. By branching, the aorta diminishes in caliber, and each branch of it, in like manner, diminishes by sub-division. The force of the current is in consequence divided and sub-divided, according to the number of the branches. But though in this way the momentum of the current becomes more and more diffused in proportion to the increasing number of the sub-divisions of those vessels, the velocity of the current in each is maintained by reason of the narrowing of each, until its individuality becomes lost in the capillary field, where momentum is so reduced as to be scarcely appreciable, and where, consequently, velocity is at its minimum rate. Hence as it is by the *momentum* of the blood (not by its velocity) that aneurisms are dilated, we can discern (in the form of the arterial system, which effects in this manner a change in the force of the circulation in the ratio of the divergence of that force from the centre to the periphery,) the reason why aneurisms are more frequently occurring in the parts proximate to the heart, which is the only agent propulsive of the arterial blood. The disease is the most frequent in the *ascending* part of the aortic arch; less so in the *descending* part; still less so in the *branches;* and least frequent of all in the *sub-divisions* of those branches, and according as these multiply the currents. In this computation may be included individuals of all ages and both sexes, although it be true that those of different ages and sexes are in different degrees liable to the disease.

When the summit of the aortic arch is aneurismal, the origins of the primary branches are generally more or less involved; and when either of these is the seat of the disease, it for the most part occasions some deformity to the aorta. In either case, very nearly the same effects, as consequent on the pressure of neighbouring parts, are produced. Like the aorta from which the branches spring, they are more or less subject to aneurism, according to their proximity to the heart. Thus the innominate artery is oftener dilated, and attains a much larger size than the left carotid, and this than the left subclavian.

Aneurisms assume various forms, according to the manner in which the arterial coats yield. They are also distinguished into several kinds. In shape they are *uniform*, *sacculated*, and *pouched*. In kind they are *true*, when the arterial tunics invest them; *false*, when by a wound or rupture of the arterial coats, the blood becoming extravasated into the cellular tissue, forms of this a receptacle; and *dissecting*, when by a rupture of the inner coat of the vessel, the blood passes between this and the outer coats. In noticing those varieties, however, the object is only to show of how very little practical importance the pathological fact may sometimes be. And as to the question, whether aneurism occurs at first by a change of structure, by a weakening, by a rupture, or by a dilatation of one or of all the arterial coats, what shall solve it if it be not the fact that it may occur by either circumstance. But of whatever kind the tunics of the aneurism are in its first stage, there cannot be a doubt that in its last stage, the structure of these is not only not identical with that of the artery, but has never been part of the vessel; for of every part with which the tumour has come in contact, it forms for itself a new investment, and outgrows the original. Of this, aortic aneurism, arising within the pericardium, and protruding subcutaneously on either side of the sternum, is an example, and illustrates the whole. The form of the aneurism determines not only the shape and quantity of the coagulum within it, but also the speed with which this is deposited. If the caliber of the vessel widen uniformly, such will be the shape of the aneurism, and in this a coagulum is less likely to be formed soon; for as the aneurism is the direct channel from the heart, the blood sweeps through it freely. But if a part of the artery yield on either side, so as to be out of the direct line of impulsion, the spot forced becomes the narrow mouth of the aneurism subsequently formed, and the latter, acting as a diverticulum for the blood, (as a lake receiving and not transmitting,) either deposits a coagulum and gradually obstructs further entry, or widens its boundary to receive additions, or bursts a vent for them.

The effects of aneurism which call for notice in a work of this kind, are those which arise from pressure on neighbouring parts. In whatever place an aneurism arises, it is sure to cause a double impediment to the circulation of the blood, *a tergo* through the artery, and *ad*

PL. XVIII.



M & N. Hanhart imp.

frontem through the accompanying vein; and in this way it affects the parts of the body on all sides of it. The artery while dilated, does not possess those physical properties which it had when of its natural proportions, and which are so essential to the free transmission of the blood. The deformity of the vessel occasions a diversion of the blood from its direct course; scatters the force of the heart's impulse on the blood; and hence on the distal side of the aneurism, the current in the vessel is weakened both in momentum and in velocity. According as the increasing aneurism obstructs the direct circulation through the main artery, the branches anastomosing above and below, gradually increase in size, for establishing the collateral circulation, and when those branches become themselves involved in the disease, the limb perishes. The accompanying vein suffers pressure from the aneurism almost from its first stage. This is an effect which more especially results in the thoracic, cervical and axillary regions, where bones, muscles, and dense fasciæ, &c., resist for a long time the expansion of the tumour, and thereby turn the pressure of it back on the vessels themselves. In all places, too, where aneurisms are formed, large and important nerves are situated, and suffer either by pressure or by being stretched. In cases of thoracic aneurism affecting the arch of the aorta or the root of either of the primary branches, not only are the functions of circulation and innervation liable to be impeded, but likewise those of respiration, deglutition, and nutrition. There is scarcely a point of the aortic arch from which an aneurism originates, but by its pressure it involves some vitally important part, not excepting the heart itself.

The symptoms of all aneurisms are in themselves similar, but they are liable to be masked by various circumstances. Upon this the difficulty of diagnosis altogether depends. If we except the differences of structure according to which aneurisms are named, and which are in no way necessary to inform us of the existence of the disease, or its distinction from other affections, and which, moreover, are of no moment in respect to its cure, then we reduce nomenclature to mere essentials and name the disease according to its place. It is, indeed, from our knowledge of a place being frequently the seat of aneurism, that when other signs are not very marked, we are at first led to the true character of the disease when existing; and many a serious error of judgment would not have been committed even by the most distinguished surgeons if this knowledge were allowed its due weight in diagnosis. As all arteries in their normal condition are similar in form and structure, and are more or less subject to the heart's action, so in disease they manifest the influence of that action in the same way. The pulsation, and the peculiar murmur which attend all aneurisms, are synchronous with the systole of the left ventricle, and both those signs are occasioned by the entry of the blood into the interior of the tumour. Those symptoms are peculiar to aneurism. They do not attend on any form of varicose veins, for the heart's impulse does not reach them through the capillaries. Whenever those symptoms are obscured, this cannot be owing to the form of the aneurism, *per se*, but to the existence of structures (healthy or otherwise) which surround it; and, as in the case of thoracic aneurism, to the sounds and motions of the disease being lost in those of the heart and lungs. The chief sources of fallacy in the diagnosis of aneurism in the neck or upper limbs from swellings which simulate it are these: 1st. Any tumour may assume the aneurismal form. 2nd. Any solid tumour situated in connexion with an artery may have a pulsation communicated to it from that vessel. 3rd. By compressing a main artery on the proximal side of a tumour, which has a motion from the vessel, we arrest that motion whether the tumour be aneurismal or not. 4th. A tumour may be an aneurism containing a large solid coagulum, and thus maintain its volume, even though we exert pressure on itself or the artery leading to it. 5th. A tumour may not be of the aneurismal kind, and yet yield and lessen in volume when compressed, as for example an abscess bulging on the superficies, and leading from sinuses deeply situated. When, however, with those doubtful signs the positive ones are present and obvious, the former serve to make assurance doubly sure. If a vein or the sac of an abscess form a communication with the canal of an artery, the case is to be included in the category of aneurisms and treated accordingly.

On considering aneurism in reference to the heart's action and to the general form of the aortic system, the following ideas occur to me as having a very material bearing on the operative treatment of that disease. 1st. The part at which an artery is aneurismal would seem to prove that the vessel on the proximal side of the tumour is in a healthy condition, for were it not so, it must have yielded nearer to the heart than it has done; and therefore we need not fear an unsafe hold for the ligature, owing to any disease in the coats of the vessel above the tumour. 2nd. As the aneurism abates the heart's force, in respect to the distal part of the artery, this part cannot suffer dilatation, even though it be degenerated in tissue; and therefore the proper site for the ligature is, in all cases which admit of it, above the aneurism, where we may presume the vessel is healthy. 3rd. As the form in which the aortic system ramifies, moderates the heart's force, from the centre to the periphery, so the development of aneurisms must have a certain order as to the time and place of their appearance. If, for example, the same artery be affected with two or more aneurisms, that one which is most *distant* from the heart must, I maintain, have been the *first* to appear, for the aneurism once existing, prevents the heart's action taking effect beyond it; whereas the vessel on its proximal side is still in the same condition in regard to the heart's action, and consequently is yet liable to be forced on subsequent weakening of its tunics; such is the order in time. The order in place is a consequence of the heart's action affecting more directly the arteries of the right side of the body than those of the left, owing to the curve of the aortic arch being from right to left, and also to the form of the primary branches. It is known that the innominate and its branches are more subject to aneurism than the branches of the left side. 4th. When the aneurism affects the ascending aorta *first*, none of the branches of that vessel are in the *second* instance subjected to the disease, or can be because of the tumour weakening the heart's impulse on the blood at its source. The same happens in respect to the branches of the innominate artery when that vessel is first the subject of aneurism. But if either the right common carotid or subclavian become aneurismal, the disease affecting the one *distinct* vessel cannot abate the heart's circulating force in respect to the other, and so the unaffected one is liable still to become aneurismal in any part of it, even at points more remote from the heart than the aneurism of the vessel first affected, and at periods secondary in time. 5th. Arteries of the first class, such as the innominate and common iliac; of the

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FIGURES OF PLATE XVIII.

FIGURE I.—The aneurism, L L, springs from the right subclavian artery, F, inside the anterior scalenus muscle, I, which is bent outwards by the tumour. The internal jugular vein, DD, the external jugular vein, T, the vagus nerve, the clavicular part of the sterno-mastoid, the omohyoid muscle, M, and the branches of the subclavian artery, are borne forwards. The aneurism reaches the posterior inferior cervical triangle, where it covers the brachial plexus of nerves, K, and hence might well be mistaken as originating in the artery, F*, at this situation.

FIGURE II.—The aneurism, L, is represented by an uniform dilatation of the right subclavian artery, F*, outside the anterior scalenus muscle, I. The omohyoid, M, and the transversalis colli artery, together with the external jugular and another vein, lie in front of the aneurism, the subclavian vein, J, is below it, and the brachial plexus is behind it. In a case of which I have a sketch very similar to this, Mr. Liston tied the origins of the subclavian and carotid arteries, and death ensued from secondary hæmorrhage. The post-mortem examination showed the veins distended from pressure—the anterior jugular cut—a coagulum above and below the ligature of the carotid—the subclavian divided by the ligature, which adhered to the proximal end of that vessel—the distal part separated from the ligature and open—the branches of the subclavian (which were all of them outside the ligature) were pervious.

FIGURE III.—Represents the state of the parts as they appeared some years after the cure of an aneurism, L L, of the right subclavian artery, F*, outside the scalenus muscle, I. The brachial plexus of nerves, K K, appears embedded in the aneurismal remains, and the branches 1 2 3 4 5 6 7 8 are enlarged for the collateral circulation.

FIGURE IV.—A pyriform aneurism, L, is formed from the left axillary artery; it is embraced by the axillary plexus of nerves, and it compresses the vein on its inner side. The artery was tied above the clavicle.

FIGURE V.—A large globular aneurism, L L L, of the right axillary artery, F, appears with the nerves, K K K, stretched over it, and with the axillary vein, J, so compressed by it on its inner side as to be impervious, J*. Below the tumour the basilic vein, G, is seen much distended. The cephalic vein, E, is of its ordinary size. The lesser pectoral muscle, A, is adherent to the anterior wall of the tumour.

FIGURE VI.—Represents a "dissecting" aneurism, B*, of the right brachial artery, B. The coagulum lies between the inner and middle coats of the vessel. A, the basilic vein. C, the median nerve.

FIGURE VII.—A small aneurism, A, appears on the radial artery, B, at the wrist.

FIGURE VIII.—An aneurismal varix, A A, involves the brachial artery, I, and median basilic vein, G. The veins of the forearm are much distended and enlarged. The brachial artery, I, shows a high division, I I*, into two branches, which unite, I** at the bend of the elbow below the varix. The median nerve, H, lies between the two arteries. This state of parts resulted from a wound of the artery in venesection. That one of the arteries which did not directly communicate with the vein, was tied, but of course without the desired effect.

second class, such as the subclavian, common carotid, external and internal iliac; of the third class, such as the brachial and superficial femoral; and of the fourth class, such as the radial and ulnar, the posterior tibial and peroneal are in that order as to caliber, the subjects of aneurism as to frequency. This is explicable by the circumstance that the farther the vessel is from the heart, the smaller is its caliber, and the less the momentum of the current to which it gives passage.

As all aneurisms, and especially those of arteries near the heart, are destined to increase in size, and as the spontaneous cure is a very rare exception to their progressive growth and fatal issue, it can admit of no argument, considering these circumstances alone, that the sooner the most suitable form of operation is undertaken to control the disease, the better the chance of attaining that result. There are, however, cogent reasons for arresting the full development of the disease as soon as its existence is known; of those reasons the principal are these, viz., the greater the dimensions of the tumour the more likely is it to involve the origins of the collateral branches, and render it impossible for them to carry on the anastomotic circulation. When those branches are destroyed, and the main artery is tied, the limb then has no more chance of maintaining its vitality than if it were amputated. The larger the aneurismal tumour, the more it shortens that interval of the vessel to which a ligature is to be applied. The larger the aneurism, the more it distorts from their natural relative position the artery and the adjacent parts, thereby rendering it difficult to find the course of the vessel in an operation. The only reason that can be assigned for delaying operative measures, is in order to give time for the full establishment of the collateral circulation, by directing gradually to the branches the heart's action which has been impeded by the disease on the main arterial channel, but this is a result much more often frustrated than realized by these very means.

Aneurism of the innominate artery, Pl. XVI., admits in no instance of the application of a ligature to that vessel itself. The shortness of the artery, its large size, its contiguity to the aorta and the pleural sac, its inaccessible position within the thorax, and the fact that the dilatation, even at an early period, involves the whole length of the vessel, are circumstances forbidding the operation. The same anatomical facts render deligation of this vessel inadmissible for an aneurism of one of its branches near its bifurcation. The indication, therefore, for the treatment of such cases is (as in that of aortic aneurism) to lessen the quantity of the circulating blood, and to abate the heart's action, or to try the effect of tying one or both of the branches of the innominate artery on the distal side of the tumour. When the innominate is obstructed by an aneurism of itself, or when the branches are tied at their roots for an aneurism of the common trunk, the collateral circulation in respect to the distal parts can only be carried on by such branches of the vessels of either side as anastomose across the median line of the body, viz., the offsets of the two internal mammary across the sternum, and laterally with the superior intercostal and thoracic branches of the axillary; the superior and inferior thyroids of opposite sides in the thyroid body; the two facial and supra-orbital, &c., across the middle line of the face and forehead; the two vertebral in the basilar artery, and the branches of this joining those of the internal carotid within the cranium. The right innominate vein is that which suffers direct pressure from this aneurism, and the consequence is congestion of the veins of the right side of the head and those of the right arm. The nerves which are subjected to compression are the right vagus, phrenic, and sympathetic; and hence the effect on the larynx, œsophagus, lungs, heart, stomach, and diaphragm.

Aneurism of the right common carotid artery, Figures 1, 3, 5, and 8, Pl. XVII., is circumstanced much less favourably for a cure by deligation than the corresponding vessel of the left side, and for these reasons, viz., it is more directly exposed to the action of the ventricle, and it is shorter by the length of the innominate artery. The higher up and the smaller a common carotid aneurism is, the more readily and effectually it admits of the vessel being tied below it. When this artery is tied, the collateral circulation is maintained in respect to the head and neck, by the opposite thyroid, facial, lingual, temporal, pharyngeal, internal carotid, and vertebral, across the median line. The vagus nerve, and the internal and external jugular veins, (particularly the former vessel,) are subjected to compression.

Aneurism of the external carotid artery, Figure 2, involves the whole length of that vessel, and therefore presents the same anatomical conditions, and demands the same operation as is required for aneurism of the upper part of the common carotid. The aneurism if large, will interfere with deglutition and speech, by preventing the motions of the lower jaw, larynx, pharynx, and œsophagus, and by pressure on the lingual and laryngeal nerves.

Aneurism of the internal carotid artery, Figure 6, will, if small, and situated on its upper part, admit of the vessel being tied below it, for the internal carotid is, opposite the thyro-hyoid interval, on the same plane with the common and external carotid. But if the aneurism spring from its lower third, Figure 7, it becomes necessary to tie the common carotid at its upper part. When the internal carotid within the cranium, Figure 9, is aneurismal, there is, during life, no sign by which to distinguish it from any other tumour. And if there were, it may be doubted whether deligation of the vessel in the neck would result in any other benefit than arresting for a short time the increase of the aneurism. The direct communication (circle of Willis) between the basilar artery and the internal carotid within the head, would maintain the entry of blood into the aneurism.

Aneurismal varix of the common carotid artery and internal jugular vein, Figure 4, requires deligation of the former vessel below the tumour, as in the case of aneurism. Since it is the direct force of the arterial current opposing that of the venous current which causes the vein to dilate, it would seem, *à priori*, to be sufficient and admissible to tie the artery immediately below the opening, for the disease is not owing to a degeneration of the coats of the latter vessel.

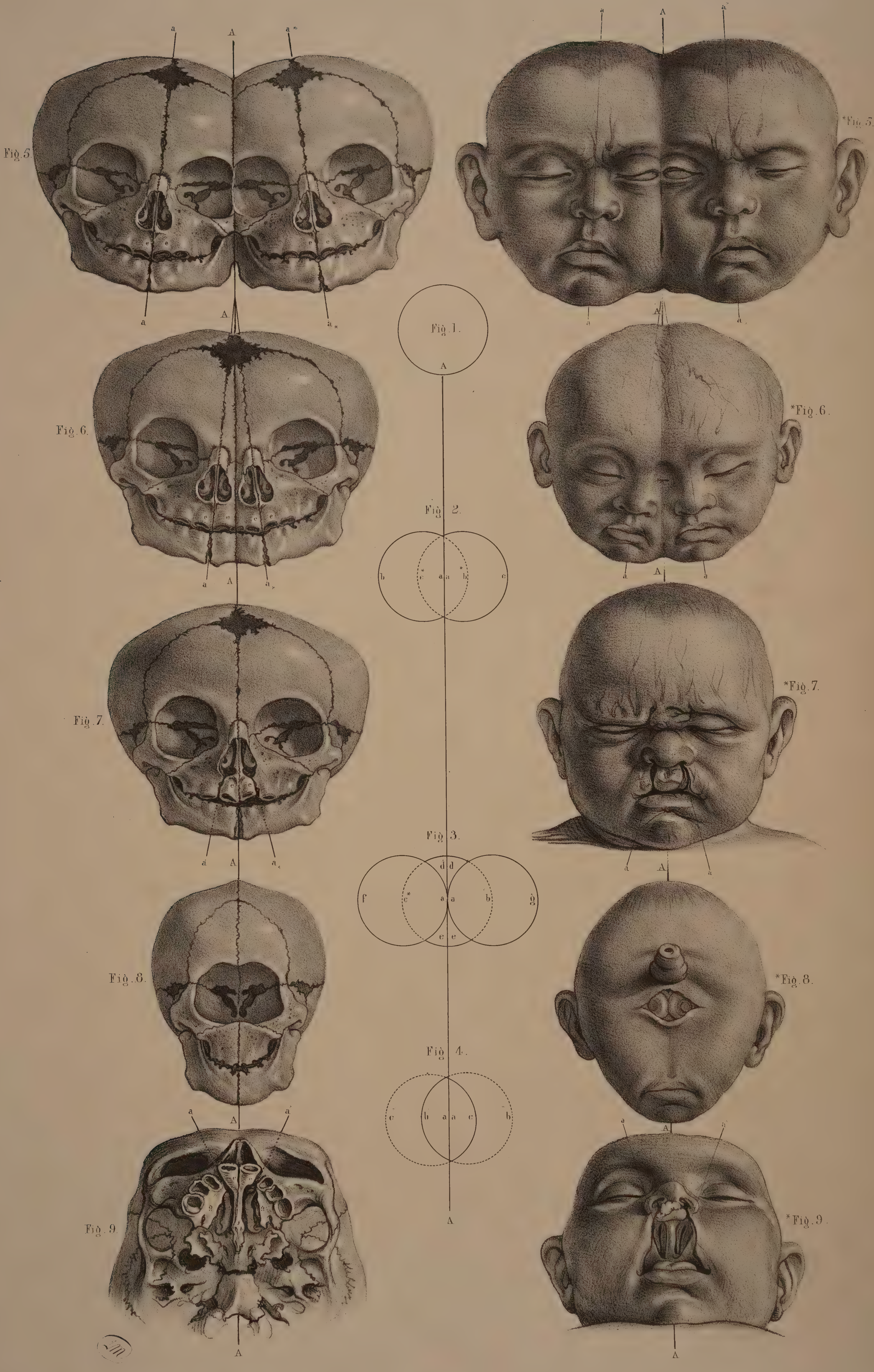
Aneurism of the right subclavian artery, Pl. XVIII., Figure 1, within the scalenus, would, even if small and close to that muscle, scarcely allow of a ligature being placed around the proximal end of the vessel; for the ligature here must necessarily be either close to the root of the common carotid, or among the origins of the numerous branches arising from the subclavian itself, and in contact with the pleura, the vagus nerve, and internal jugular vein. To those facts is to be ascribed the very unfrequent successful result of this operation; and the experiment of tying at the same time the lower end of the carotid or the innominate itself, has been followed by no more favourable issue. For an aneurism close to the outer side of the scalenus, fig. 2, the most eligible site for a ligature would appear to be behind that muscle, but the difficulties attending this operation are scarcely less in number than those of the former. If the ligature be placed inside the subclavian branches, the collateral circulation in respect to the arm can be maintained from but comparatively few sources—viz., the opposite inferior thyroid and the internal mammary branches communicating across the median line; and (as is not unfrequently the case) if the inferior thyroid arise from the common carotid or the innominate, the anastomosis of this branch is then of no account. But if the ligature be situated external to the branches, then the anastomotic circulation for the support of the limb may be carried on by numerous channels—viz., by the inosculation of the superior intercostal and mammary with the axillary thoracic branches, and by that of the supra-scapular and tranversalis colli, and also, that of the posterior scapular, with those branches of the axillary—viz., coraco-acromial and subscapular, &c.—which ramify about the shoulder bones. If the aneurism be inside the scalenus, it will compress the internal and anterior jugular veins, and also the vagus and phrenic nerves. If it be outside the scalenus, it will press against the brachial plexus and the end of the external jugular vein; but the subclavian vein, occupying a lower level than it, passes free.

Aneurism of the axillary artery, Figs. 4, 5, whether small or large, is so surrounded by the brachial nerves, leaves so little space for a ligature, and is so deeply situated, that there can be no doubt in any case of the paramount necessity of tying the vessel immediately above the clavicle, where those disadvantages are not so much in force, and where, moreover, the number of anastomotic channels for effecting the circulation of the limb is (if not more) certainly not less than if the ligature be placed lower down in the axilla. In axillary aneurism the nerves are always stretched, causing pain, numbness, or paralysis of the arm, while the pressure which obstructs the axillary vein, and sometimes obliterates it, induces a varicose state of its formative branches with œdematous tumefaction of the member.

Aneurism of the brachial artery, Figure 6, determines the site at which the vessel is to be ligatured; but if a choice may be made, the ligature should be applied below the profundi branches, and if not, the best situation in regard to anastomosis would (for reasons before mentioned) be either in the axilla or above the clavicle.

Aneurism of either the radial or ulnar artery, Fig. 7, would only require a ligature on the proximal side of the tumour, without regard to anastomotic branches, for the other arteries of the forearm freely communicate in the hand.

Aneurismal varix at the bend of the elbow, Figure 8, requires the brachial artery at its lower third to be tied, and it may be also necessary to apply a ligature to the vessel, below the tumour.



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COMMENTARY ON PLATES XIX. & XX.

THE SURGICAL DISSECTION OF THE PARTS DESCRIBING THE FACIAL MEDIAN LINE. SYMMETRY. UNITY AND DUALITY. SPECIES. MONSTROSITY. SIGNIFICATION OF THE INTERMAXILLARY BONE AND LABIUM LEPORINUM. MECHANISM OF THE DUPLEX CRANIO-FACIAL APPARATUS. STRICTURE OF THE ŒSOPHAGUS.

Amongst the most remarkable, and yet the least understood, manifestations of animal formation, are those referring to the median line of the body. They are creations as visible, and tangible, and ponderous as cannon balls. We see them in the dissecting-room, in the hospital, in the museum, and in the fields of Nature in every direction; and, nevertheless, there are those who, though *professing* anatomy, live as little inquisitive of their signification as they are of the "quadrature of the circle." These are they, however, who would account not more interrogative than Cheapside rubbish, the never-yet-touched vestal *marine* shell-bed strown on the empyrean untrodden peaks of snow-capped Himalaya, or entombed deep as Hades in Palæozoic rocks! Not less significant of some unknown meaning than this, appears to me the facial deformity familiarly named "hare-lip;" and as a surgical subject, I think it demands our inquiry into its origin and development as much as an aneurism or a hernia. What I have to say of it I shall put, for brevity, in the propositional form.

Every organic form is symmetrical.—Throughout all variety of special forms, whether normal or abnormal, it is noticeable that not only does the order of the graduated series, 9, 8, 7, 6, 5, 4, 3, 2, 1, relate them to one another, but that the condition of symmetry characterizes them in common; and this so absolutely, that just as each one is cleavable through its longitudinal axis into two equals, so by an extension of that line through all those forms (supposing them to be arranged in linear series) it would be found not to swerve in the least degree from a right line from one end of the animal kingdom to the other, and thence may be produced from end to end of the vegetable kingdom likewise. This law of symmetry distinguishes the organic from the inorganic forms.

Every organic form is symmetrical by the union of two individuals.—The form, when considered in regard to symmetry, will be found to be fashioned of two figures, respectively complete, and similar, and equal to each other. In order to see the distinctiveness of the right from the left form by the exact junction of which the body results, it becomes necessary (as indeed it is for the appreciation of most great truths) to look from a point to some distance in time and space around. In the stages of development from the embryotic to the adult, we trace through the persistence of symmetry a coalescence of lateral parts in different situations along the median line. Thus, as in the developmental phases of the individual, we recognise beings (distinct in time) transient the preceding one into the succeeding, so in the phases of coalescence of the right and left body, we mark two beings (distinct in space) becoming, from the state of duality, a symmetrical unity. The cranio-facial apparatus is an example of this. The fœtal head is marked vertically into halves; and the plane of its division, instead of being merely ideal, is *actually* described by a septum which consists in itself of two laminæ representing respectively the junction sides of the distinct right and left cranial forms. The *interparietal suture* is at an early period produced backwards through the middle of the occipital bone, as the *interoccipital suture* to the *foramen magnum*, which is a *central hiatus*, and forwards through the middle of the frontal bone, as the *interfrontal suture* to the fronto-nasal junction, whence it extends as the *internasal*, *intermaxillary*, and *interpalatine sutures* through the centre of the sphenoid bone to the foramen magnum. Between the right and left cranial forms we find the septal laminæ, or inner sides of the two, partly osseous and membranous. But this structural difference is none as regards form; and as a proof, we find that parts of the septum, viz., the *falx cerebri* and *cerebelli*, which are membranous in one species, are osseous in another, and in the same way divide the cranial interior into two chambers. The facial apparatus is likewise marked double by a *septum nasi*, which is in the same plane as that of the cranium, and, like this, consists of two layers. This duality, which is thus plainly marked in the osseo-membranous forms of the head, is not less noticeable in regard to its contained organs; and, in fact, the condition of the one bespeaks that of the other. The brain is double. It is divided naturally into a *right* and *left organ*, and the junction sides of the two form its *median septum*, which is in the same plane as that of the cranium and face. The *corpus callosum* is marked by an antero-posterior central *raphe* representing the junction of the opposite cerebral hemispheres. Corresponding with this raphe is the *septum cerebri*, being also of two layers partly separated, and standing perpendicularly between the middle line of the *corpus callosum* and that of the *fornix*. The *fornix*, like the *corpus callosum*, presents a *median raphe* and covers the *third ventricle*, which is a space or median interval between the *optic* and *olfactory bodies* of each lateral cerebrum. On the base of the brain, we trace the antero-posterior middle line of junction, also coinciding with that of the cranium above, and the face below. In like manner, the *cerebellum* is *bilobed*, and the *medulla oblongata* is *centrally furrowed*. The cerebro-spinal nerves are in pairs on either side of the middle line, the nerves of the right brain forming a series opposite that of the left. This natural bipartition of the head and its organs is traceable through the body and its organs likewise.

The primitive organic unity is devoid of a median septal plane, Fig. 1.—In the primordial organism, the earliest definite form which is created is the spheroid. This form is an example of simple symmetry; for in whichever direction it be cleft, provided this take effect through its centre, the resultant halves are similar to each other both in form and quantity. But the hemisphere, unlike the sphere, is an imperfect form, inasmuch as it does not enclose space. It is a form of mere surface, with its concavity corresponding to its convexity. The circumference of the hemisphere is a circle, but the plane of section which has separated it from its opposite is not represented in substance. The simple spheroid is therefore incapable of division into two complete enclosing forms, because of the absence of a median septum. The lowest grade of organic being—the monad—is the representative of this simple sphere; but there is not to be found in any of the higher classes of animals, and especially not amongst the vertebrated, a single instance of nonseptal formation. To prove that a median septum is the indication of duality, and the absolute distinctiveness of the right and left forms, we have but in fancy to cleave the head through its septal plane, and contemplate either the right or left form separately. The septum then no longer exists in that capacity. Instead of the central position which it occupied when the two forms were side by side in union, it is now divided into two parts or surfaces, which respectively belong to each of the cranial forms, and is a side for each. In either form we now no longer view bilateral symmetry as marked by a septum, and consequently that form is not naturally bipartite. No *lateral* organ of the body is symmetrical *per se*, for the opposite organ is necessary to this condition, and then it only appears in respect to the *two* side by side. Every *azygos* organ is symmetrical, as formed of similar sides joined; but the side itself is devoid of this character. When we view the lateral unit of the dual head, it presents a single cranial chamber occupied by a single cerebral form: it has but one orbital cavity, one nasal, half an oral cavity, and half a tongue.

FIGURES OF PLATE XIX.

Figures I., II., III., IV.—Diagrams explanatory of the law of the median fusion of simple plural forms into a symmetrical septal compound form.

Figures V., VI., VII., VIII., IX., V.*, VI.*, VII.*, VIII.*, IX.*.—Representations of natural forms contained in the Musée-Dupuytren and Jardin des Plantes, of Paris, the Musée-Anatomique de la Faculté de Médecine de Strasbourg, and that of the College of Surgeons of London, and selected as illustrations of the same law in phaseal operation.

But when the head is considered in regard to both its lateral forms in apposition, the symmetrical duplicity, not only of it as a whole, but of its contained organs and its cavities, manifests itself. That duplicity is necessary to symmetrical unity, and is the very essential meaning of this character of form in the vertebrated classes, is a question solvable in the most simple mode:—when with closed eyes I describe on half this paper an inky figure of the most bizarre form imaginable, and fold it against the opposite half, the lateral figure, now impressed double and united, is regularly symmetrical. And what form is there more devoid of symmetry than the lateral cephalic unit? No one of its points or curves is like another. In no line of division can its resultant segments be made to resemble one another; and yet when placed in natural relation to its opposite unit, dissimilarity vanishes from the presence of symmetry, as darkness from light.

A median septum can only result from the coaptation of two hollow elastic spheres, Figs. 2, 5, 6, 6*. —When within a given space two elastic spheroids are posited so that by tending to a common centre, *a a*, they compress each other, the two units so compressed represent a figure differently constituted from that of either appearing *per se*. Those sides of the two in contact form, in respect of the dual figure, a median septum with two plane layers. But though the primitive spherical form of each unit be now changed, *a b*, and no longer in bilateral symmetry, yet it remains a complete form as enclosing space, and distinct from its opposite. The bilateral symmetry of the now double form, *b c*, is that of duplicity in regard to a septum, *a a*, at the middle line. The existence of this septum is therefore a proof of duality.

A median septum, being of two layers, must have four sides, Figs. 2, 5, 6, 6*.—This is self-evident; for as the spherical unit, *b b*, fig. 2, has an inside and an outside, so when the two units, *b b*, *c c*, tend to each other, and their sides in contact form the median septum, *a a*, of the now dual figure, that septum must have four sides, two of which look towards each other centrally, and two from each other laterally, into the interiors of the units with whose peripheries they are respectively continuous. The median and symmetrical cavities of the body are merely the intervals between the septal layers. The fifth ventricle between the layers of the septum cerebri formed beneath the corpus callosum, the two lateral, the third and fourth ventricle, are the interspaces between the two cerebra, just as the thoracic mediastinal spaces are the intervals between the two pleural sacs.

The extent of a median septum is in the ratio of the cohering surfaces of the two forms, Figs. 2, 5, 6, 6*.—If the two units merely touch at a point, such will be the condition of the septum: if they tend together so much as to compress their adjacent sides, *a a*, fig. 2, to an extent equal to the vertical diameter of each, such will be the extent of the septum. Between those two extremes, all the degrees of median tendency determine those of the superficies of the septum.

When the diameter of the septum equals that of either lateral unit, the dual form is spherical, Figs. 3, 7, 7.—Each unit, *a f*, *a g*, fig. 3, being spherical, and of equal diameter, and their tendency to a common centre, *a a*, causing a flattening against each other, in suchwise that their respective centres, *c b*, meet at a common centre, *a a*, then of course each unit now representing a hemisphere, *d c e*, *d b e*, the two constitute a sphere, *d c e b*, by the coaptation of their plane median surfaces, *d d*, *e e*. But though in outward appearance the now dual form be spherical, like the lateral unit in its primitive state, yet the former differs from the latter by the presence of a septum.

Three septa indicate the coalescence of four units, Figs. 3, 7, 7*.—When of three spherical forms the middle one, *c b*, fig. 3, is compound or septal, *d e*, and the two lateral, *a f*, *a g*, simple or nonseptal; and when the two lateral tend to the septal centre, *a a*, of the intermediate one, *b c*, the triplex form thus resulting must have three septa, of which one is that, *d e*, already existing in the middle figure, *c b*, and the two others, those formed respectively by the cohering flattened outer sides of the middle figure, and the adjacent sides of the lateral ones. In the triplex septal form so constituted, it will be observed, that while the lateral members are now rendered plano-convex, or hemispherical in respect to the common centre, the middle one is rendered bilaterally plane or discoid, being compressed between the two outer ones, and occupying the interval between them.

The intermaxillary and triquetral bones are the remains of a middle septal between two nonseptal forms, Figs. 3, 7, 7*.—This is explicable by the last proposition. Those bones, when existing, are invariably posited at the cephalic median region, and are naturally bipartite and symmetrical. The intermaxillary bone, *e e*, fig. 7, is duplex by reason of a central suture, and on this suture the two-layered septal vomer stands. Between the intermaxillary and maxillary bones of either side, a suture, *a a*, also appears, and each of these should, according to the present views, likewise support a septum, (making three,) and would be found to do so, (fig. 6,) were it not that the cases which have hitherto come under notice (fig. 7,) are those in which the centralizing fusion of the lateral cephalic units has, in respect to the nasal compartment, proceeded so far as to render this double from having been quadruple. The ossa triquetra appear at the fontanelles, still separate from each other at the central line, and from the other bones externally. In the lower animals, we find an interparietal pair of bones, representing here what the intermaxillary pair does in the face. The interparietal and the triquetral bones are homologous, just as are all intermaxillary bones wherever they appear, whether in the human or any other species.

The cranio-facial apparatus, plus or minus the intermaxillary and interparietal bones, renders all species uniform or difform accordingly, Fig. 7.—The intermaxillary bones, *e e*, are normal in the lower animals generally. The absence of them would be a normal character of the human species, and in this respect the latter would differ from other species, and thus appear as an exception to general uniformity. The absence of the human intermaxillary bones is however not proved. The interparietal bones are present as a normal character of some species, and absent as a normal character of others. The normal absence of the latter in the human cranium does not therefore characterize this as different from many of the lower animals. But when the human form exhibits the intermaxillary and triquetral or interparietal bones it reverts to the general animal type, and establishes uniformity between them and it. Specific distinction is therefore only as $a + b$ and $a - b$, the presence or absence of a plus quantity, *e e*, which it is potential in nature to effect in any species or in all.

The fusion of dual features indicates the excess of median concentration, Figs. 4, 8, 8*.—When the two lateral cephalic units, *c c**, *b b**, fig. 4, tend to the common centre, *a a*, so far that their respective centres cross each other in a certain degree, they form an ellipse, *b c*, whose longest diameter is vertical; in such case, the central unit (if it have existed) becomes wholly obliterated. The two orbital cavities appear now as one. The two nasal compartments, which were between the two orbital are absent. The nasal appendage is either absent or displaced above the cyclopic eyeball, which still is dual by the union of two organs. The oral cavity is contracted laterally, the palate narrowed, and the incisor alveoli wanting. Thus, according to the degree of centralization undergone by the lateral forms, the head appears plus or minus as to central parts, and the condition in which it presents itself (be this human or of any other species) is abnormal only as excess or defect of quantity, and normal when of the mean quantity by which we judge of species.

The relative order of the abnormal and normal parts proves them equally elements of design.—A part, whether abnormal or normal, always appears at the same place, and, with its opposite, exhibits symmetry. No elemental part of any kind appears in any place without its counterpart. At the median line, the homologous parts are in exact coaptation. In a lateral region, a part, though separated from the median line, has its counterpart in a similar place on the other side. The intermaxillary elements are never internasal, interfrontal, or interparietal. Such a change of place is in fact no less impossible (because never occurring) than for the frontal elements to appear where the maxillary are, or *vice versâ*.

The fusion of two or more units into a symmetrical form is potential, but the division of one unit into two or more perfect symmetrical forms is an impossibility.—This is proved in the foregoing propositions. Three cephalic spheroids may concentre into a symmetrical and septal spheroidal one; but one simple nonseptal spheroid cannot be divided into three forms which respectively inclose space completely, or which can present themselves in any other character than that of being segments of spheroidal unity.

The law of a centralizing fusion of plural forms into a septal symmetrical one governs development throughout the animal kingdom, Figs. 9, 9*.—This is demonstrable, especially in the higher classes of animals. All the normal forms of the piscean, the reptilian, the avian, and the mammalian types are symmetrical, and marked with a septal median line showing two lateral forms in union. In every species of those classes, nature presents us with an analysis of the phaseal passage of two or more individuals to that union. In every class, order, genus, and species of vertebrated animals that have come under my observation, I have noticed instances of bipartition along the median line in all degrees from the mere bifid condition of the frame to that in which it appears sundered into two individuals adhering but at a point. Those are the stages of coalescence of plural forms into one. The beings in those stages form the class of *double monstres.* The beings in the *last* stage of complete septal symmetrical union constitute the animal in its normal character. The beings in

Fig. 1.

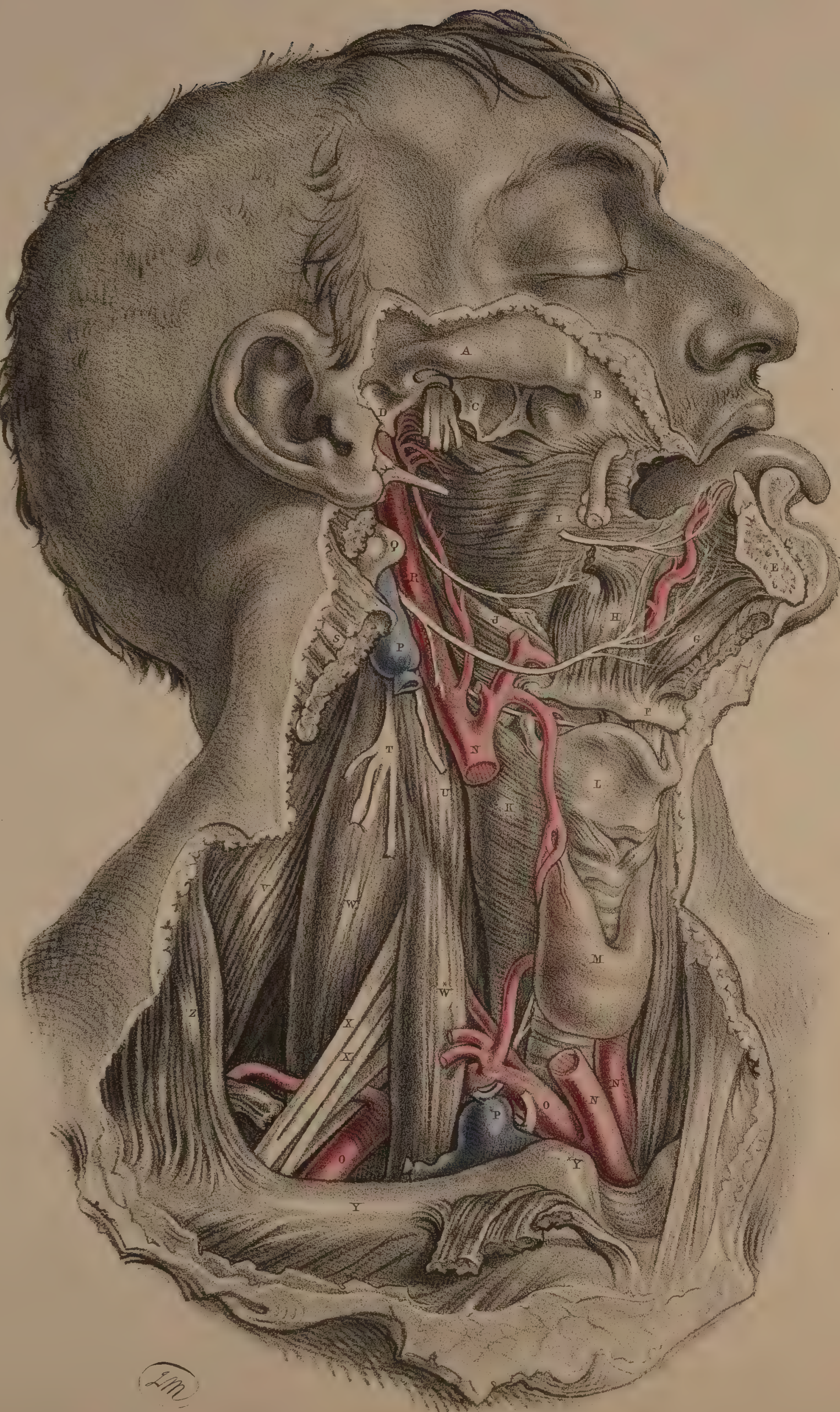


Fig. 3.

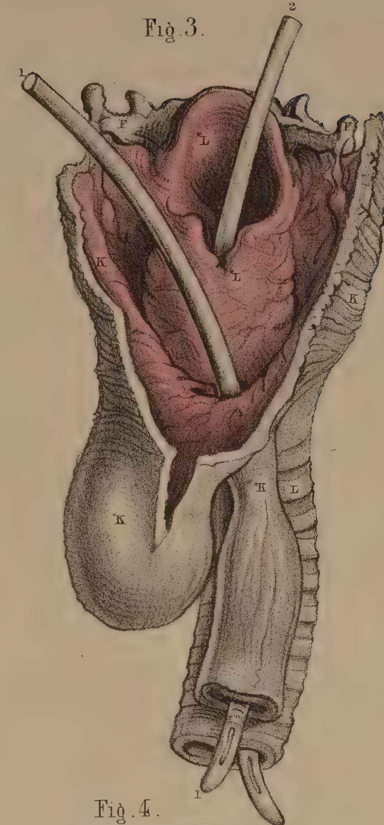
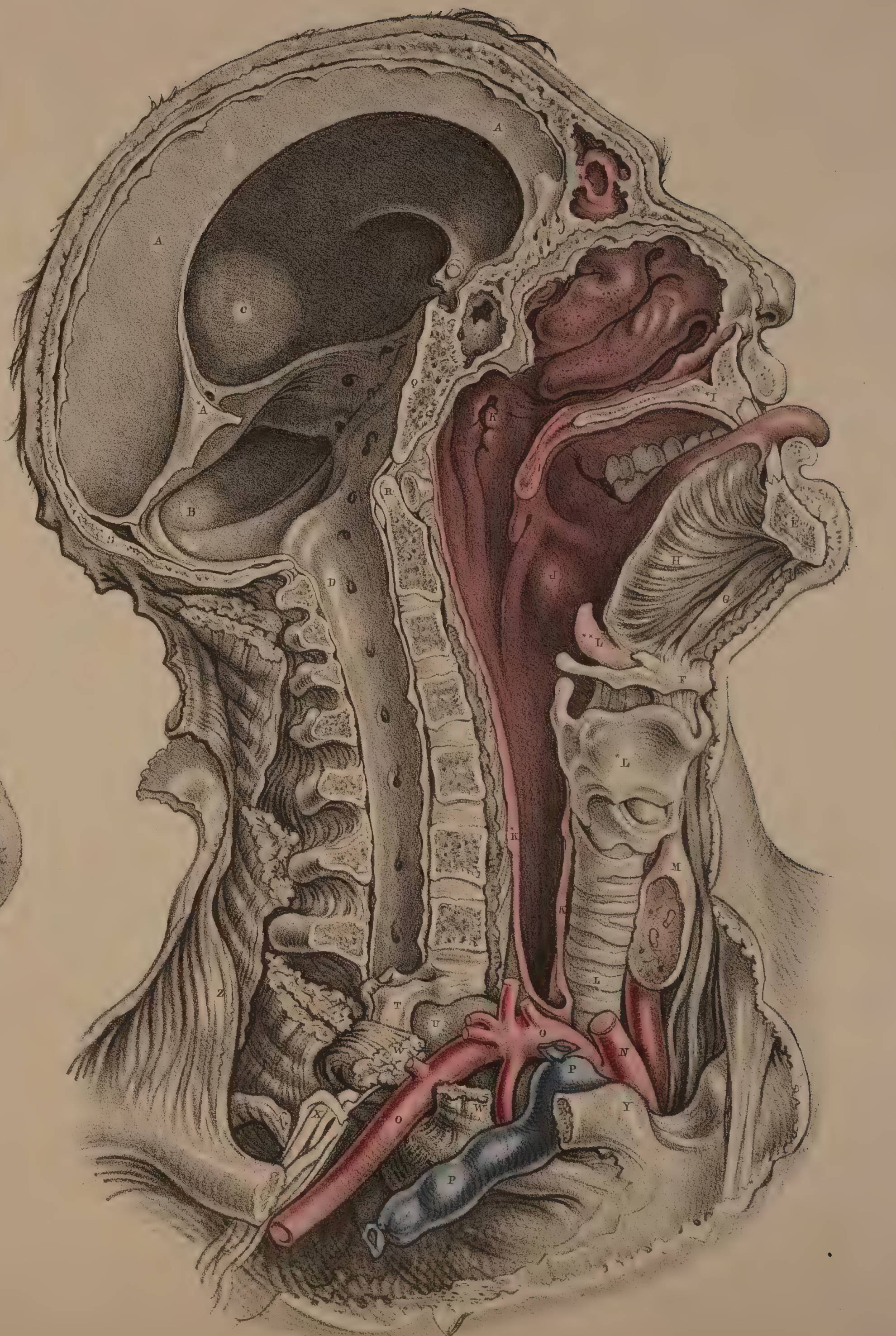


Fig. 4.

Fig. 2.



the *penultimate* stage of median coalescence represent the animal with the intermaxillary bones, cleft lips, and palate.

On making a section of the head and neck vertically through the median line, we bring in view the form and relative position of the structures of those parts, and the cavities they bound. The bodies of the cervical vertebræ and the basal centres of the skull are in the same median series; and the latter separate the cranial from the facial cavities. The continuity of each of the cranio-spinal membranes now traceable is not more evident than that of the mucous membrane lining the frontal, nasal, maxillary, oral, laryngeal, and pharyngeal compartments. This extension of the same membrane from part to part explains how certain pathological conditions, at first local, may become general.

The cranial cavity is wholly occupied by the brain and its membranes: the form of the one is determined by that of the other. From the outward form of the cranium may be judged that of the brain, but not so of the spinal cord in the vertebral canal. The cranium may be regarded as subcutaneous in all its parts, forming its roof from the occipital spine to the fronto-nasal junction, and from one zygoma to the other. The plane between these four points would indicate pretty accurately the position of the base of the cranium in the living body, and the separation between it and the facial apparatus.

The cranium, owing to its undefended condition, is very liable to fracture, and when this occurs, the brain is always more or less involved. In cases of fracture with depression, or blood, or matter within the cranium, the operation of trephining is required. In performing this operation, the situation of the bloodvessels is to be noted with a view to avoid injuring them. The instrument should not be applied to any point of the median line of the cranial vault between the fronto-nasal junction and the occipital spinous process; for this marks the course and extent of the superior longitudinal sinus: nor in a line between the occipital spinous process and the mastoid processes; for this is the course and extent of the great lateral sinuses: nor below the occipital protuberance where the torcular Herophili—the point of junction of the three sinuses—is situated: nor in the temporal fossa at the anterior inferior angle of the parietal bone where the trunk of the middle meningeal artery ascends the inner surface of the cranium.

The nasal fossæ, two in number, and situated centrally in the upper maxilla between the orbits, are separated from each other by the median septum, formed by the vomer and its cartilaginous nasal appendage dividing the nostrils. The septum nasi, consisting of two plates of bone and cartilage, may be regarded as the inner sides of the two upper maxillæ applied to each other at the median line. Considered under this idea, each nasal fossa appears (what, in fact, it is) a compartment formed in the upper maxilla by a breaking up of its cancellated structure. The turbinated bones are formed of this cancellated structure curled into shell-shaped parts attached to the external wall of the fossa, and free towards the septal middle line. The maxillary antrum is also as a cell formed in the cancellated structure of the bone, and communicating with the nasal fossa; the ethmoidal cells, the frontal and sphenoidal sinuses have the same signification. All those compartments (not the nasal fossa alone) by their natural communications with each other, are hence to be viewed as necessary to the olfactory sense and the organ of voice.

Each nasal fossa, seen in the recent state with the soft parts attached, reaches from the anterior to the posterior nares horizontally, and from the roof of the mouth to the anterior floor of the cranium vertically. Its vertical diameter is largest in the middle, owing to the nasal bones being sloped downwards and forwards, while the cranial base is directed downwards and backwards. Its transverse diameter is greatest next its floor. The existence of the turbinated bones renders each nasal fossa very irregular and contracted; but while both fossæ are viewed together, they appear perfectly symmetrical. The turbinated bones, three in number, are situated one above the other—the uppermost is the smallest; the interspaces are the superior, middle, and inferior meatuses. At the back part of the middle meatus is the opening of the maxillary sinus; at the fore part of the inferior meatus is the lower orifice of the nasal canal. All parts of the nasal fossa are invested by the Schneiderian membrane; and when we consider how very vascular and glandular this membrane is, a correct idea of the nasal fossa as a space may be readily obtained. In fact, the interspaces of the parts are but as mere narrow chinks; and when polypi or other tumours appear here, they must force a position for themselves at the expense of the normal structures. As the floor and septal inner wall of each of the nasal fossæ are smooth, the instruments to be introduced into this place should be guided along those surfaces.

The oral compartment exists as a cavity only when the jaws are opened. On looking into the mouth when the jaws are widely separated and the tongue depressed, we can see the back of the pharynx supported against the cervical vertebræ. The hard palate which forms the roof of the mouth, appears extended backwards by the soft palate, which hangs as the loose velum or valve of the throat, between the posterior nares above, and the fauces below. Between the velum palati and the back part of the tongue, may be discerned two ridges, arching laterally from above downwards. These, and their fellows of the opposite side, constitute the pillars of the fauces. Between the two pillars on each side appears a prominent mass—the tonsil covered by the mucous membrane: in rather close relation to this body posteriorly, the internal carotid artery ascends. In the lower lingual-maxillary trench, close to the frenum linguæ, appears the single orifice of the duct of the submaxillary gland of either side, and the several smaller orifices of the ducts of the sublingual gland. In the buccal trench, beside the upper jaw, the parotid duct opens, opposite the last molar tooth. The frenum linguæ is formed by the mucous membrane reflected in the median line from the floor of the mouth to the under-surface of the tongue, and frequently is of such a form as to restrain in infancy the motions of that organ.

The pharynx is a musculo-membranous sac or vestibule common to the mouth and posterior nares. Laterally, it corresponds with the interval between the lower jaw and sterno-mastoid muscle, and is here in close connexion with the internal carotid artery, the parotid gland covering both. Being a muscular organ, its dimensions vary during deglutition, to which action it is principally subservient; but it plays also a most important part in modulating the voice. In order to obtain a full view of the pharynx, it is necessary to make a transverse section of the head through the occipital basilar process, and then the facial half with the pharynx can be bent forwards from the vertebræ. In separating the pharynx from the vertebræ, the loose cellular connexion between both parts will explain the freedom with which the former can move in deglutition; and how when the connecting bonds are thickened (as from inflammation of the glands of the vertebral—œsophageal grooves) dysphagia may be the consequence. The pharynx is perfectly symmetrical, consisting, like the tongue and all median organs, of two forms united. On its posterior surface a median tendinous raphe appears dividing the constrictor muscles, which are three in number, and overlapping each other from above downwards, the superior one being partially overlapped by the middle one, and this by the inferior. When viewed laterally, the superior constrictor will be seen to arise from the pterygo-maxillary ligament, the middle from the cornu of the os hyoides, and the inferior from the side of the thyroid cartilage. The connexion of the two lower constrictors and of the styloid muscles with the laryngeal pieces accounts for the consentaneous motions of the larynx and pharynx, and indicates that both those organs equally serve for the functions of voice and deglutition.

The pharynx is infundibuliform. It hangs from the basilar process of

FIGURES OF PLATE XX.

FIGURE I.—A, Zygoma.—B, Upper maxilla.—C, External pterygoid process.—D, Glenoid fossa.—E, Lower maxilla, cut.—F, Os hyoides.—G, Genio-hyoid muscle.—H, Hyoglossus muscle.—I, Buccinator muscle and superior constrictor of pharynx.—J, Middle constrictor of pharynx.—K, Inferior constrictor of pharynx and œsophagus.—L, Thyroid cartilage and trachea.—M, Thyroid body.—N N, Right and left common carotid arteries, cut.—O, Right subclavian artery.—P P, Upper and lower end of internal jugular vein.—Q, Transverse process of atlas.—R, Internal carotid artery.—S, Sterno-mastoid muscle, cut.—T, Cervical plexus of nerves, cut.—U, Rectus capitis major muscle.—V, Levator anguli scapulæ muscle.—W, Scalenus posticus muscle.—W*, Scalenus anticus muscle.—XX, Brachial plexus of nerves.—Y Y*, Clavicle and sterno-clavicular articulation.

FIGURE II.—All parts, except the following, are marked as in Fig. I.—A A A*, Falx cerebri and tentorium cerebelli.—B, Cerebellar compartment.—C, Cerebral compartment—D, Spinal canal and foramina, lined by the dura mater.—H, Genio-hyo-glossus muscle.—I, Velum palati, in section.—J, Tonsil projecting between pillars of fauces.—K, Eustachian tube, opening behind the nares.—K K, Œsophagus, opened.—Q, Sphenoid bone, in section with the basilar process of occipital bone.—R, Odontoid process of axis.—T, Vertebral end of first rib.—U, Summit of pleural sac with the subclavian artery arching over it.

FIGURE III.—A posterior view of the œsophagus, K, showing a pouch, K*—(formed by protrusion of the mucous membrane through the muscular fibres)—immediately above a stricture.—K**, Situated opposite the cricoid cartilage. The catheter, 1, is passed through the œsophagus; the catheter, 2, through the trachea.

FIGURE IV.—Shows a similar view of a stricture, K*, of the œsophagus, K, at the same place, with a bougie, 1, passed through it.

the occipital bone, and, gradually contracting from above downwards, terminates in the œsophageal tube behind the cricoid cartilage. This is naturally the narrowest part of the pharynx: here it is most liable to stricture; and here also foreign bodies are frequently arrested. When we open the pharynx along its posterior median line and turn its halves aside, we bring in view the nasal, oral, laryngeal and œsophageal openings. The relative position of those openings, when the parts are in repose and in motion, may now be ascertained. The pharynx receives them all at its front aspect. The two posterior nares are the uppermost, and present the dividing median septum, which, with the other boundaries, gives each naris a quadrilateral form. The posterior end of the lower turbinated bone is visible, and immediately behind the inferior meatus appears the orifice of the Eustachian tube. On removing the mucous membrane from the borders of the nares and the upper surface of the velum palati, we expose two small pairs of muscles, (the levatores and tensores palati of either side,) arising from points immediately above the nares, and becoming attached to the velum. Those muscles, besides acting on the velum, serve to contract the nares and modify the nasal sounds. The oral aperture is separated from the nasal by the velum. This structure, prolonged from the hard palate, constitutes the soft palate, and performs the office of a valve in respect to the nares and the mouth alternately. The velum is symmetrical: it has a raphe at its middle line, and this is produced through the uvula marking the symmetry of this little appendage also. In cases of cleft palate, the parts are always separated at the median raphe; and the uvula, naturally azygos, now appears dual, each half being moveable by a distinct levator muscle. From the lateral attached borders of the velum, two ridges on each side arch downwards; one to the root of the tongue, and the other to the side of the pharynx. Those ridges on either side are the pillars of the fauces, and those of opposite sides form the fauceal arches. The two pillars are formed by two muscles, which project the mucous membrane inwards. On dissecting the membrane, the muscle of the anterior pillar (palato-glossus) and that of the posterior one (palato-pharyngeus) appear, having their origins and insertions as their names indicate. The velum palati, then, having eight muscles—two superior and two inferior on each side, and the action of those of both sides being in opposition, and making traction from the central raphe, while those above and below are likewise in opposition; we can understand how, in cases of cleft palate, the separated sides of the velum should, under their influence, present the appearance as though the part were altogether wanting. The operation *staphyloraphy* consists in the section of as many of those muscles as can be reached in order to allow of the approximation of the sundered parts to each other along the median line. The cleft hard palate is not influenced by the action of the palatal muscles. The degrees of palatal cleavage are: 1st, the double uvula; 2nd, the divided velum; 3rd, the divided soft palate; 4th, the divided hard palate, with the vomer seen in the centre; 5th, the divided palate and lips, with the intermaxillary bones.*

Between the two pillars of the fauces is the fossa, occupied by the tonsil, which varies as to size in different individuals. The posterior orifice of the oral cavity, opening into the pharynx, is the isthmus faucium bounded above by the velum, below by the root of the tongue, and on each side by the pillars. The dimensions of the isthmus vary considerably, according to the position of the tongue and the action of the muscles forming the pillars. In the use of gargles the fauces become completely closed and prevent the fluid coming in contact with any part behind them. When the tonsils enlarge in inflammation, they contract the passage, and in many instances close it entirely, so that respiration becomes altogether nasal. When the mouth is shut, and the dorsum of the tongue applied to the palate, the velum palati with the uvula pendent on the roof of the tongue, closes the isthmus faucium, but the pharyngeal cavity being permanent as such, allows the air to have free access to the glottis through the posterior nares. At the root of the tongue, immediately above the glottis, appears the fibro-cartilaginous epiglottis, which is ordinarily erect, and which, on the elevation of the larynx in deglutition, closes like a valve the opening of this organ. Below the glottis, opposite the cricoid cartilage, appears the œsophageal opening, which is ordinarily closed by a slight tonic contraction of its circular fibres. The œsophagus itself is usually of a shape compressed from before backwards. Its interior is not tubular: except during the passage of aliment, its sides are in contact. The œsophagus is so deeply situated between the laryngot-racheal apparatus and the vertebral column as to be almost surgically inaccessible. It occupies the middle line behind the upper part of the trachea, but it inclines slightly from it to the left side of the root of the neck, at which situation the operation of œsophagotomy has been performed. While the head is thrown back, the nasal and oral cavities look almost vertically towards the pharyngeal sac. This is the position instinctively taken by the patient for his own ease when instruments are being passed into the œsophagus by either passage. The epiglottis, if encountered by the instrument, will generally prevent this from entering the glottis, and guide it to the œsophagus. This object will be further secured by directing the instrument along the back of the pharynx. When the instrument enters the œsophagus it becomes grasped, indicating the usual contracted state of this organ. When, in suspended animation, we endeavour to inflate the lungs through the nose or mouth, it is necessary to press the larynx against the vertebral column so as to prevent the air passing by the œsophagus to the stomach. The natural inspiratory motion of the thorax inducts the air through its proper canal, and does not affect the œsophageal opening; but the case is different when the air is forced by extrinsic effort.

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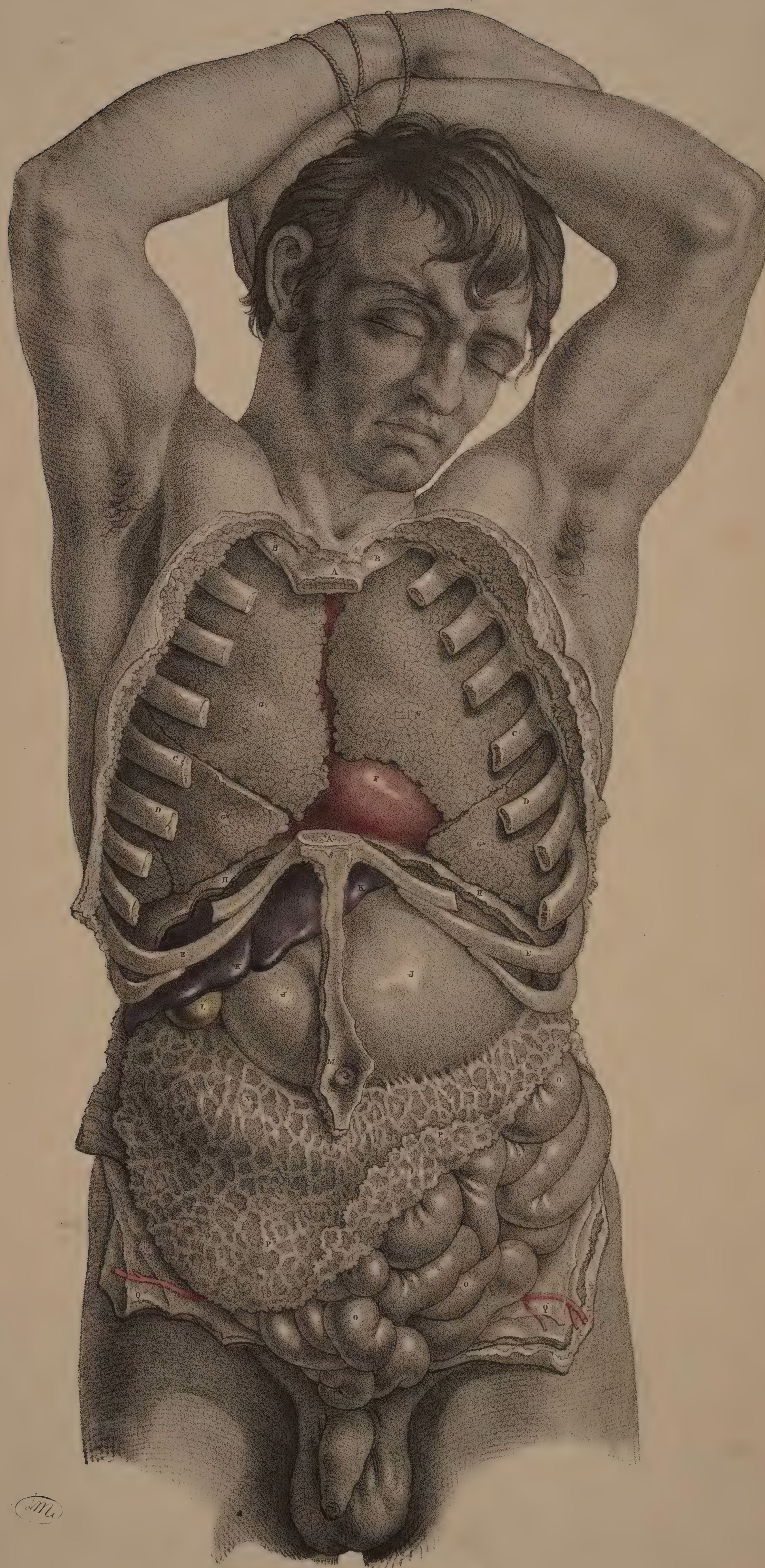
* On consulting the works of those anatomists who have recorded their views respecting the intermaxillary bones with labial and palatal fissures, I find much difference of opinion amongst them. Ackermann writes,—"Reperimus enim per totum corpus non rara vestigia degeneratæ in brutorum naturam humanæ fabricæ, ita ut inter multas rariores excitem species—os intermaxillare, aperto indicio: aliquando in homine maxillas, uti in brutis magis versus anteriora protrusas fuisse, cranii recedentis amplitudine diminuta." Göthe, Meckel, Bertin, and Beclard also assert the presence of the intermaxillary bones in the human fœtus. Professor Owen shows an indication of them in an adult human skull. But Cruveilhier states his never having observed them as parts independently developed in the normal fœtal head, though he admits their existence in cases of hare-lip, and hence that it is probable they exist normally. Now a question of this sort as to a mere anatomical matter of fact, one would suppose might be easily settled: either the parts exist or they do not. If they do, let not the absurd prejudice of the human anatomist blind him to the recognition of them, for they cannot assimilate his species to that of brutes, more than the existence of his frontal bones, provided, &c. I have myself seen those osseous pieces in a human fœtal head of normal form, whilst in others I could not discern them; but from this, rather than conclude that nature is normal in respect to our conformation in the latter condition and abnormal in the former, I would reconcile both facts in the very probable circumstance that the parts when present are still disunited from the maxillary bones, and when seemingly absent are united to them. That such is the actual state in either case, I have no hesitation in asserting; and, as a proof of this, I would instance the existence of the incisor teeth, which are proper to the intermaxillary bones only, and which, were those bones absent, could not themselves be present. Moreover, the anterior palatine canal and foramen incisivum, with the persistent fissure that is directed from them (as may be seen in even many adult maxillæ) to a point between the incisor and canine tooth, further illustrate the fact. Taking then those features as indicative of the original distinctiveness of the intermaxillary bones in all human heads, we have therefrom an explanation not only of the situations in which facial fissures may occur, but also the number in which they can occur, viz., at the middle line, and on either side of it at the maxillar-intermaxillary junctions.

For those abnormal appearances in all their degrees between that of complete hiatus through the bones and soft parts, and that in which the lip is merely notched at the prolabium, anatomists have assigned two different causes: some with Cruveilhier account them "*absolute departures from nature*,"—a term which must seem very vague, inasmuch as we cannot conceive nature departing from herself; whilst others, with Geoffroy St. Hilaire, consider them, and certainly in strict accordance with the facts, as "*arrests of development*." With the latter view, Professor Vrolik, the most recent writer on Teratology, agrees, as all must do indeed, while it is demonstrable that the formation of the facial features, like all others in central situations, occurs by a closure and fusion of lateral parts at the middle line. This mode of development being traceable in the human fœtal condition, and instances of imperfect median union, such as those of cleft lips, maxillæ, and palates occasionally presenting themselves in the newly-born, the explanation of these is plainly deducible: hare-lip is a phasis in that process of union, whereas the normal features result by the completion of that process, and still exhibit traces of the original state, which proves that the form which is now perfect, has been imperfect—has passed from the greater state of dehiscence to the less so; and might have appeared to us (had nature been arrested in any one of her developmental stages) as any of the so-called anomalies under notice actually do. The form of the upper lip is due to the presence of the intermaxillary bones. The median vertical furrow of the lip corresponding to the median intermaxillary suture is a vestige of the primitive central labial fissure in the human embryo and of that which is permanent and natural in many of the mammalia. The two labial ridges which bound this furrow, and which correspond with the two maxillar-intermaxillary sutures, are the parts in which in cases of single and double harelip the clefts invariably occur, and each ridge is an indication of the union in this place as the furrow is in that.

Now when from the particular consideration of hare-lip we pass in review all those varieties of conformations—the so-called *Lusus Naturæ*, which are characterised by a fusion of individuals at a common median line—we cannot fail to recognise them all as a class transitional the one into the other. As things of a series naturally related and as the results of the same creative process, the true explanation of any one of them (if we would seek it at its root) must serve for all of them. Being creations of the same order, Pl. XIX., I would therefore isolate them from the indiscriminate heap of mere malformations, which, occurring from either blighting accident, or pathological fault, can serve no more to elucidate the operation of the *lex formativa*, than can the mutilations effected by the craniotomy forceps. Of these the *Acranial*, *Anencephalic*, *Acephalic*, *Monopodial*, &c., are examples, and have scarcely a more direct reference to the normal course of *genesis* than the *Hydrocephalic* or than those resulting from *mollities ossium*. But when we contemplate the *Heteradelphi* in all their degrees of union (from that of a *Siamese-twin-duality* to that of a hare-lip fissure), we find them expressing one connected sentence, enunciative of nothing if not of a *gradational coalescence of plurals to a state of singleness*. These are the truly called *monstres* in the sense of the derivative *monstrare*, for they demonstrate (witness, with the philosophic Serres, the exact coaptation of the homologous parts of the individuals comprising *Ritta-Christina*, which cannot be ascribed to chance) a law of development taking as determinate a course as that of the hand on the dial, and which, to the unbiassed ken of science, must appear as luminous a phenomenon as lightning, and as real a one as gravitation.



M & N. Hanhart, Impᵗ

COMMENTARY ON PLATES XXI. XXII. XXIII. XXIV. & XXV.

THE FORM OF THE ABDOMEN AND THE RELATIVE POSITION OF ITS CONTAINED ORGANS IN HEALTH AND DISEASE. PARACENTESIS. PENETRATING WOUNDS. DELIGATION OF THE AORTA AND COMMON ILIAC ARTERY. HYSTEROTOMY. OVARIOTOMY. MECHANISM OF THE THORACICO-ABDOMINAL APPARATUS.

In outward configuration the thorax and abdomen constitute an entirety, the members of which, even in process of dissection, we cannot consider irrespective of each other, without losing sight of their combined meaning. Just as the integument forms a common envelope for both parts, so are the muscles connected with both, and by their action affect both and the organs proper to each; and so likewise does the perfect skeletal trunk form a framework for both. We cannot, while we contemplate the perfect skeleton, isolate the thorax from the abdomen by fact or fancy; for, considering the skeleton *morphologically*, that is, in regard to its fibrous, cartilaginous, and osseous parts, the only difference between those regions results simply from the circumstance that the sterno-costo-vertebral osseous circles, which completely gird thoracic space, have not their complete counterparts of entirely *osseous* structure encircling abdominal space. This difference is, however, merely *histological;* for while the posterior parts of the thoracic ribs are serially represented by the "transverse processes" of the lumbar vertebræ behind the abdomen, so are the anterior and middle parts of the thoracic ribs, as bone, represented in the abdomen by the *linea alba* centrally and by the *lineæ semilunares and transversæ* laterally. That these fibrous intersecting bands of the abdomen are truly the homologues of the thoracic costo-sternal pieces of the thorax in man and the mammalia, is a fact demonstrable in the forms of the lower classes of animals. In the human species the osseous ribs are not of invariably the same number; for we notice occasionally an increase of the normal number of *twelve*, both at the summit and the base of the thorax. At the summit one or more supernumerary pair of opposite ribs appear, and, according to their number, decrease the length of the cervical spine as ordinarily formed, and increase that of the dorsal spine. At the base of the thorax, too, the same occurs, and produces the same result in regard to the dorsal and lumbar spine. Now, as the presence of those supernumerary ribs is invariably attended with the absence of those processes of a cervical or lumbar vertebra, which are named "transverse," what other signification can the fact have than that the transverse process itself is the anchylosed vertebral end of a rib? Seeing, then, that that part which is numerically and locally the same in one human form is not quantitively the same in all individuals of that species, we may fairly conclude that the difference is simply that of *plus* and *minus*; and if, from this point of view, we pass in survey all species of vertebrata, we shall find that their multitudinous designs result by the same simple mode of creation—namely, the subtraction from an integer or whole archetypal quantity. In many of the reptilian and avian species the costal arches encircle the thoracico-abdominal region as if it were a common *pulmonary* chamber. In the piscean and some of the reptilian species the costal arches enclose the cervical, thoracic, and abdominal regions, as if they were a common *abdominal* chamber. In man and the mammalia, the costal arches completely enclose the pulmonary chamber only, and those costæ, as *bone*, fail at that region where the ventral organs are located, and likewise at the neck. While, therefore, on comparing the human abdomen with the thorax, we record the anatomical difference that the thorax is costo-sternal and the neck and abdomen non-costo-sternal, that fact and its final cause cannot appear more evident to the sense than the signification of it must appear to the reason. *The parts of a whole quantity which are present must relate of the parts which are absent from that quantity*, and thus we have ever prefigured to us the idea of that whole. A semicircle is part of a circle. When I am shown a human thorax *minus* its anterior costo-sternal part, I know not only that the thorax wants that part, but also that it once existed and is now abstracted, else it would still exist. The human neck and abdomen, *minus* the like parts, must express the same signification. The parts have been subtracted from the whole quantity, and the remainder is a neck or an abdomen; but if those parts still existed, the abdomen and the neck would still be costal, like a thorax. The want, therefore, is the design; and the subtraction of the parts now wanting is the act of a designer as clear as if we saw and felt his hand corporeal plying.

When with those ideas which the skeletal fabric of the trunk comparatively contemplated suggests, we dissect its soft parts and its viscera, the task is attended with an interest not otherwise to be realized. Thus, if we figure to ourselves a form consisting of a series of sterno-costo-vertebral circles reaching from the maxillæ to the pelvis—and such an archetypal form is in nature—we shall see that the human form itself describes that very same condition. In order to recognise this fact, we must divest ourselves of the idea of a skeleton as consisting of bone only. The process of ossification being of three stages—a fibrous, a cartilaginous, and an osseous,—and that part which now exists as bone having passed through the fibrous and the cartilaginous stages, it follows that the true and complete skeleton must consist of parts in those three stages; for, if we except the fibrous parts as imperfect, so ought we to except the cartilaginous parts also for the same reason; and then we reduce the skeletal thorax itself to a form incomplete, since not encircling space. But when (as reasonably we must do) we include in the skeleton all the parts which respectively represent those three stages, we perfect the ideal form, and, in doing so, we place the actual design in a clearer light, for now the abdominal walls are ribbed by substance in the first (fibrous) stage of the ossific process, as suitable to their motions in respect to the enclosed parts; while the thoracic walls are ribbed by substance in the second stage (cartilaginous) and in the third stage (osseous) as conducive to their proper function. Under the same point of view we can figure to ourselves not only the proximal, but also the remote physiological signification of the cranio-facial and cervico-laryngeal apparatus; for, now comparatively considered, the larynx is to the cervical vertebræ, and the maxillæ to the cranial vertebræ, what the costo-sternal apparatus is to the dorsal spine, viz., as parts of whole dorso-ventral quantities placed *seriatim;* and hence the analogy between the facial, laryngeal, and costal forms, as anterior parts of the skeletal trunk, must—however diversified by modification to special functions these necessarily are, (and mark in that modification the existing design!)—be still as real a condition as that at once apparent between cranial, cervical, and dorsal vertebræ. In those general considerations we may, besides their physiological import, perceive their practical application likewise, if it be only to show that costal inclosure does not actually isolate thoracic from either cervical or abdominal space. The line of separation between those compartments, so very indefinite in the lower animals, is a condition to no small degree apparent in the human form also, and hence the liability of the pathologist to err in his diagnosis between the healthy and diseased organs of either region, for all in mass lie in relation to each other with only the pleura between those of the neck and those of the thorax, and only the diaphragm separating those of the thorax from those of the abdomen, while the motions of that muscle influence all at

FIGURES OF PLATE XXI.

A A*, Upper and lower ends of the sternum.—B B, First ribs.—C C, Fifth ribs.—D D, Sixth ribs.—E E, Ninth ribs.—F, Pericardium.—G G*, Lobes of the right and left lungs.—H H, Diaphragm in section.—J J, Stomach.—K K, Lobes of the liver.—L, Gall-bladder.—M, Umbilicus.—N, Omentum covering transverse colon.—O O O, Small intestines—P P, Omentum covering them.—Q Q, Right and left halves of the abdominal parietes turned aside.

the same time, so that the level which it occupies when quiescent, is alternately taken during respiration, by those organs which are applied to its upper and under surfaces. For these reasons it becomes necessary to consider the whole trunk as a fabric one and indivisible, and to have at the same time under notice the organs which occupy it.

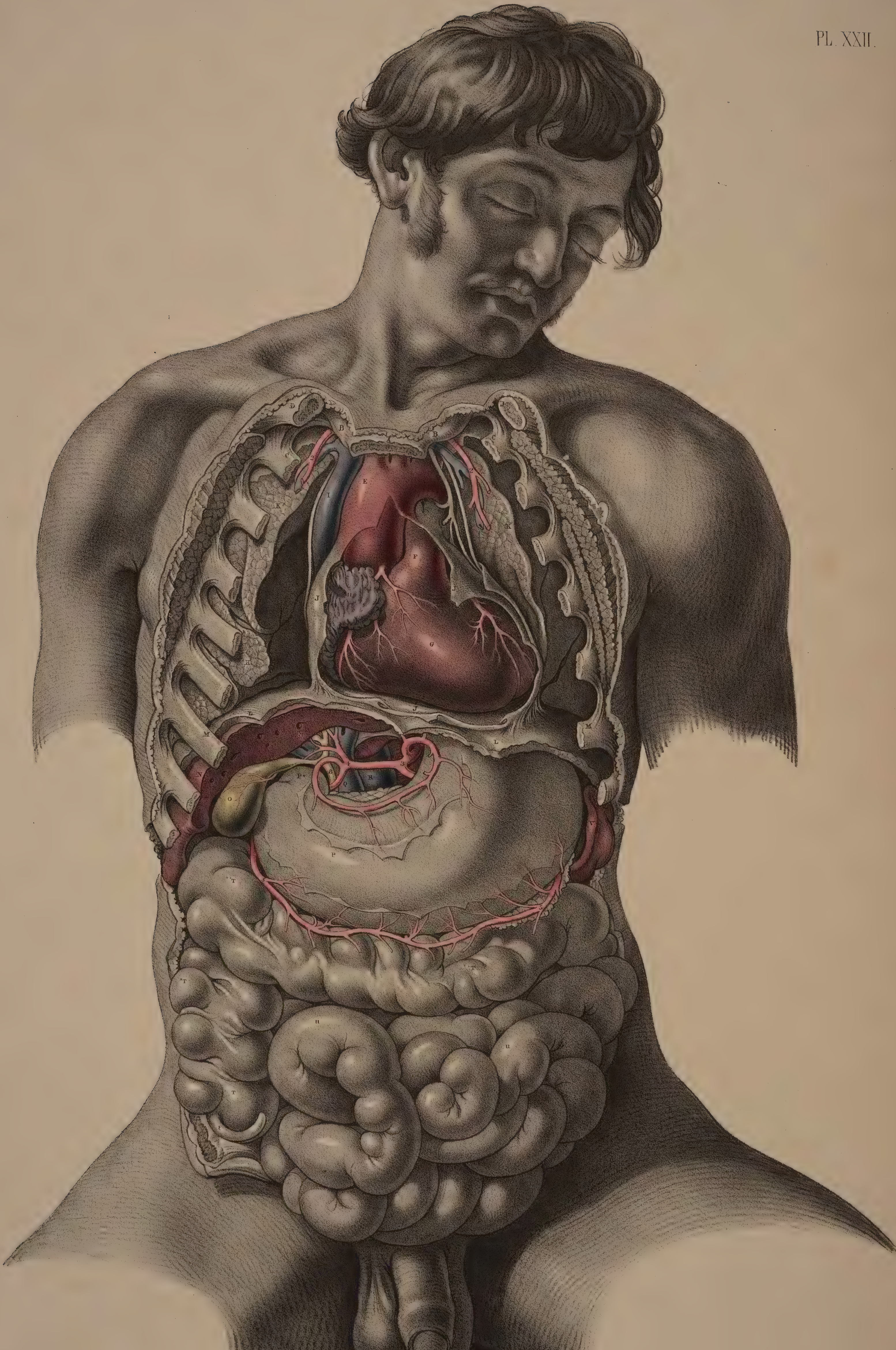
The abdomen is usually mapped out on its cutaneous surface by certain artificial lines, dividing it into regions, so as to serve to indicate the position of its organs. It is marked also by *natural* lines, sufficiently apparent in most individuals, and those lines will, it seems to me, much better answer the same end. The compartment in which the abdominal viscera are contained, is at all times of greater capacity than the thorax. The diaphragm divides the two. The margins of the false ribs, which can be felt beneath the surface, extending from the xiphoid cartilage in front downwards, and backwards to the twelfth dorsal vertebra, give attachment to the diaphragm; but as the form of that muscle is not plane between the opposite margins of the ribs, but rather considerably arched, the height of its arch, which varies from one to three inches from its attached border, according to the respiratory motions, gives the height to which the abdominal chamber projects into the costal region through the span of the lower ribs. The false ribs, then, are in fact more abdominal than thoracic. From the summit of the diaphragmatic arch to the plane indicated by the brim of the true pelvis, we mark the vertical extent of the abdomen. The form of this chamber is the reverse of that of the thorax. The vertical diameter of the front of the thorax is of less extent by a third than that of its back; while the vertical diameter of the front of the abdomen is greater by a third than its back. In both the erect and the supine posture the abdomen assumes this form, and it is due to the fact of the diaphragm and pelvic brim being so inclined from each other, that a perpendicular drawn from the middle of the one would intersect that of the other at the umbilicus. This congenital mark—the navel, indicates the centre of the anterior abdominal wall; it is the point at which the linea alba and middle linea transversa cross each other at right angles, and divide the abdominal front into four quarters—two superior and lateral, and two inferior and lateral. The *osseous* sternum, the xiphoid *cartilage*, and the *fibrous* linea alba, represent the anterior middle line of the skeletal trunk in the three stages of the ossific process, and the three parts continuous form a line dividing the thoracico-abdominal chamber into halves, thus marking, with the laryngo-tracheal apparatus above, and the pubic symphysis below, the bilateral symmetry of the body throughout. The *linea alba* intersects the middle of the stomach between the xiphoid cartilage and the umbilicus. When the stomach is empty its inferior curve is above the umbilicus; when distended it is on a level with that point, and sometimes below it. It is an error to suppose that the stomach, on being distended with aliment during life, turns forwards and upwards in the same manner as it does when it is inflated and the front of the abdomen removed. Behind and a little below the umbilicus is situated the middle of the transverse colon. Between the umbilicus and the symphysis pubis the linea alba equally intersects the convoluted mass of the small intestines and the summit of the urinary bladder, when this organ is inordinately distended. The *linea transversa* corresponding to the umbilicus coincides with the transverse colon from right to left, but the extremities of this part of the great intestine sink backwards and upwards from the abdominal front under the lower false ribs. In the *superior right quarter*, the organs which lie in contact with the abdominal wall are the liver, projecting its margin from under the false ribs, the pyloric half of the stomach, and the gall bladder partially depending from beneath the liver. In the *left superior quarter*, the larger or cardiac half of the stomach wholly occupies that space, and is partly covered by the lower ribs. The spleen lies deeply from the anterior parietes in the subcostal recess, between the bulging end of the stomach and the ribs. In the *inferior right quarter* and in the *left* the small intestines, covered by the omentum, lie next to the abdominal parietes, upon the summit of the bladder at the middle line, and in front of the cœcum on the right iliac fossa, and of the sigmoid flexure of the colon on the left. The inferior boundary of the abdomen reaches between the opposite spinous processes of the iliac crests, and is marked by the inguinal folds produced and joined at the upper border of the symphysis pubis.

The parietes of the abdomen are constructed principally in reference to the organs contained in that cavity, but their correlation with those of the thorax is also very evident. The abdominal integument is very extensile, the subcutaneous adipose tissue abundant and elastic, and the muscles very mobile, in consequence of the absence of the ribs. On removing the integuments from the thorax and abdomen, we find the muscles stretching over the latter, between the ribs and the pelvis, and evidently, by their forms and connexions, indicating the serial analogy between those bones. The abdominal muscles, like those of the thorax, exhibit perfect symmetry. On either side of the linea alba appear the two recti muscles, invested by strong fibrous sheaths, and reaching from the sternum and seventh costal cartilages to the symphysis pubis. The tendinous intersections, which vary in number, but never exceed that of the lumbar vertebræ, whose costæ they represent, show that each rectus muscle is made up of many united for one action. On the outer border of each rectus appears the linea semilunaris, which gives direct insertion to the tendons of the two oblique and the transverse muscles—the sheaths of the recti being formed of expansions of those tendons of the broad muscles of opposite sides meeting at the linea alba. The obliquus externus arising from the outer surface of the lower ribs, where it interdigitates with the serratus magnus, also from the lumbar aponeurosis, and from the crista ilii, sends its fibres downwards and forwards to its insertion; the obliquus internus having the same origin, except that it arises from the margin of the false ribs above, and from the outer part of Poupart's ligament below, sends its fibres radiating to its insertion; the transversalis muscle, from a similar origin, sends its fibres as its name indicates. The fibres of the three muscles will be thus noticed to decussate, and from this disposition of them and the recti two principal objects are attained—viz., a variety of action (bracing) from their united efforts, and an effectual defence against intestinal protrusion. The analogues of the recti muscles are the triangulares sterni, in the thorax. The analogues of the oblique and transverse muscles are the decussating layers of the intercostal muscles. This serial homology is traceable (though in a less marked manner, owing to their extreme modification) in the cervical muscles, arising from the sternum clavicles and ribs, and inserted into the larynx, spine, and lower maxillæ. Between the jaws the buccinators and the pterygoid muscles, likewise decussating, are of the same serial order.

When we remove the front of the thorax and the abdomen, we bring in view the viscera of both cavities as they lie in their normal relative position. The diaphragm, now in transverse section, will be seen to have the heart and lungs on its upper surface, and the stomach and liver applied to its lower. By pushing the lungs from above downward, it will be found that the diaphragm offers no hindrance to the impulse being communicated to the abdominal viscera, and even to the pelvic as far as the perinæum. In forced respiration the same takes place to a certain degree, and still more so in all expulsive efforts of the whole trunk. The organs which are in structural connexion with the diaphragm are the heart, by its pericardium, the stomach, by its peritonæal investment, and the liver, by its suspensory ligaments, and thence it may be inferred that those organs must obey the diaphragm, according as it descends and ascends by the alternate inspiration and expiration of the lungs. During those motions of the diaphragm the form and capacity of either compartment undergo a change, and so likewise do their respective viscera in regard to relative position.

On comparing the thoracic with the abdominal viscera, the point which first strikes attention is the want of symmetry in the latter. This character of the abdominal organs is, however, more apparent than real, and is due chiefly to the necessary manner in which they are folded and applied to each other. In the thorax the organs are in pairs, and separated by a septum, so as to allow of a distinct action of the thoracic side on its proper lung, and on its heart through the intervention of the lung. The double circulation requires the duplex heart, and for the action of this a lung on each side of it. But a symmetrical action of the abdominal walls not being needed for the function of the viscera enclosed, we find that their symmetrical relation is not maintained. Most of the abdominal organs are single, but each of these is symmetrical *per se*. The stomach and intestinal tube throughout is fashioned of two similar sides, invested by the peritonæum; the mesentery which attaches the intestines to the lumbar spine is formed of that membrane, and consists of two layers, which, in the manner of those of the mediastinum, are reflected to the parietes, and all parts of the membrane are continuous. The liver on the right side points to the spleen as its counterpart on the left; the kidneys are a pair exactly similar as to form, and placed in opposite corresponding situations.

The abdominal viscera (like the thoracic and cephalic) are moulded upon one another, and in mass are cast in the form of their containing chamber. The solid organs—viz., the liver, spleen, and kidneys, have not their forms influenced by their respective functions or by the motions of the abdominal parietes; but the hollow organs, according as they are empty or full, of course alter in shape, and occupy more or less space. Whether empty or full, however, the stomach and intestines still lie in contact with the abdominal walls, for these contract or relax duly in the measure of the space those require. Like all the serous sacs, the peritonæum has no in-



ternal space; its sides, like those of the pleura, are everywhere in apposition, for between the viscera, which the peritonæum closely invests, one and all, there is no interspace in health, and consequently, so long as the parietes are entire, they cleave to the viscera, and these to each other, on the same pneumatic principle as the lungs do to the thoracic walls, to each other, and to the heart between them. The motions of the solid viscera are those of the thorax and abdomen in reciprocal action; in addition to those motions the hollow viscera have their own, originating in their muscular tissue. The peritonæum, bedewed with its proper secretion, facilitates those motions. The peritonæum, taken as a whole, is very much more voluminous than the two pleuræ together; and this difference is owing not so much to the collective bulk of the viscera of the abdomen being greater than that of the thoracic organs, but to the circumstance of the former being of greater number and variety of shape than the latter. In addition to this, we find the peritonæum forming duplicatures—the omenta—which do not serve as immediate investments for the viscera, and to all appearance have no other use than to extend the secreting surface, for facilitating the peristaltic motion of the intestines, and to fill more accurately the interval between these and the abdominal parietes. A true idea of the form of the peritonæum includes the topography of the whole abdominal organs, just as the form of the pleuræ gives the relative position of the thoracic organs.

The peritonæum represents at the same time the form of the abdominal chamber, which it lines, the individual form of each of the viscera of that chamber, and the exact relative position of these. Anatomists have hitherto described the peritonæum as a *single* membrane, and in that character have endeavoured to trace it from a point over the surfaces of all the abdominal viscera continuous to that same point again. This idea of the membrane cannot be accurate, as will be seen in the very mode by which they undertake to prove the truth of it. The serous lining of the abdomen, like that of the thorax, consists (as I believe) of *two* membranes, of two distinct and respectively complete sacs; and this may be demonstrated. I open the abdomen by transverse section at the umbilicus, and from this point trace the peritonæum upwards behind the anterior abdominal wall to the margins of the false ribs of either side, and thence backwards beneath the diaphragm. On passing my hand between the adjacent surfaces of the liver, stomach, and spleen below, and the diaphragm above, I feel its progress arrested by the structural connexion between those three organs and the muscle. Examining this connexion, it appears evidently to be owing to the fact of the peritonæum being reflected from the diaphragm to the *upper* surfaces of those organs. After closely investing those surfaces and the *anterior inferior half* of the liver as far as its transverse fissure, it forms, between this and the stomach, the *upper layers* of two connecting media,—the gastro-hepatic and splenic omenta, which would be more properly named mesenteries. Having gained the greater curvature of the stomach, which reaches nearly across the abdomen, the membrane descends as the *first layer* of the great omentum to its lower margin, and here turns up behind it as its *fourth or hindmost layer* to the fore part of the transverse colon, whose *under surface* it invests, and thence passes to form the *inferior layer* of the meso-colon, which is attached to the spine beneath the pancreas and duodenum. From the latter place the same membrane is traceable as the *upper layer* of the mesentery to the small intestine, which it covers, and next passes as the *under layer* also of that mesentery back again to the spine. From here it descends over the lumbar vertebræ and great blood-vessels for some way into the pelvis, where it gives a covering to the rectum, and attaches by a short mesentery that gut to the sacrum, forms a pouch between the rectum and the uterus, invests this organ, forms another pouch between the uterus and the bladder, invests the upper part of the latter organ likewise, and finally ascends the *lower half* of the abdominal parietes to the umbilicus from which it has been traced. This membrane, thus continuous throughout, represents a perfect sac; it is that which, when we open the abdomen, we see as the shining *anterior covering* of all the organs, except the colon, pancreas, and duodenum. To supply that covering to the latter parts, the *posterior covering* to the liver, and stomach, and also to form the *two middle layers* of the great omentum, requires a distinct serous membrane, and this exists: On lifting the forepart of the liver from the stomach, and exposing the gastro-hepatic mesentery, if this structure be divided transversely, its serous shining surface back and front will indicate that it consists of *two membranes* in structural connexion. The *anterior layer* of it is part of that serous sac above described; the *posterior layer* is not. The *posterior layer* is traceable from the line of section upwards to the transverse fissure of the liver, and thence to the under surface of the *posterior half* of that organ which it attaches to the diaphragm. From that point it is to be seen turning downward on the *posterior part* of the diaphragm to the pancreas and duodenum; these it invests on their *front* aspects, and thence is traceable as the *upper layer* of the meso-colon. Having reached the colon it next covers the *anterior half* of this viscus, and from its lower border descends into the great omentum between the layers of the other membrane; and, having reached the lower border of this part, turns up again, facing itself (thus forming the *two inner* omental layers), and reaches the greater curve of the stomach. Of the stomach it then forms the *posterior* investment, and is traceable upwards as the *posterior layer* of the gastro-hepatic mesentery to the transverse section of this, whence it has been traced. Such are the anatomical facts which appear to me to give proof of the existence of *two* abdominal serous sacs; and, if further proof were wanting to confirm the correctness of that view, it may be had from analogy. All the serous membranes are in *pairs*, placed opposite each other, in respect to the median line. The cranial arachnoid membrane, the thoracic pleuræ, and the scrotal tunicæ vaginales, have that disposition. The peritonæal membranes do not appear placed in lateral symmetry, but it is the relative position of the viscera which they invest that causes this. And if it be urged as an objection to the duplicity of these membranes, that they are continuous at the "*foramen of Winslow*," under the liver, it should be remembered that the lining of the uterus is continuous with the peritonæum at the fimbriated ends of the Fallopian tubes; and yet we do not account both these membranes as one. I have seen an instance in which, to all appearance, the tunicæ vaginales communicated through the septum scroti; it was a case of double hydrocele, which allowed of the fluid of one sac to be forced into the other. This communication between the tunicæ vaginales must have been a secondary occurrence, for we know that originally they are distinct productions of the lining membrane of the abdomen. The "foramen of Winslow" (if indeed it be a *foramen*, and that we are not deceived by the complication of the parts) may likewise be the result of a secondary cause. It is not uncommon for the "cavity of the omentum," which I conceive to be described by a serous membrane distinct from that which forms the "general peritonæal cavity," to communicate with the latter by a cribriform condition of the four omental layers.

The relative position of the abdominal viscera to each other and to the thoracic requires notice at the same time, whether we examine them in health or disease. In death their relative position is fixed and readily ascertainable, but during life the organs are subject more or less to a change of place, not only as regards themselves, but also their containing chambers. This occurs when the organs are in their normal condition, and should be borne in mind when having recourse to percussion and auscultation: in disease it adds to the difficulty of making a correct diagnosis by those operations. All the thoracic abdominal viscera gravitate. In the erect posture they bear down of their own weight from the summit of the thorax to the perinæum; but during this time the thoracic viscera are, in some measure, supported from the abdominal by the tonic action of the diaphragm, though both are influenced by the motions of that muscle. The abdominal organs are sustained more particularly by the *anterior* muscular parietes of their chamber than by the pelvis. The protrusion of the bowel through wounds of the abdomen proves the sustaining office of those parietes, and that while they are entire, the mesenteries must be in a state of laxity. In the supine posture the bowels gravitate towards the spine, and the parietes of their chamber are then inactive.

The *liver* occupies the right hypochondriac region beneath the diaphragm, and is suspended from that muscle by its proper ligaments. The

FIGURES OF PLATE XXII.

A, Upper part of the sternum.—B B, First pair of ribs.—C C, Second ribs.—D D, Clavicles cut.—E, Arch of the aorta.—F, Pulmonary artery.—G, Right ventricle.—H, Right auricle.—I, Superior vena cava and right phrenic nerve.—J J J, Pericardium divided.—K K, Right and left lungs turned aside.—L L, Diaphragm cut.—M M, Seventh ribs.—N N, Liver in section.—O, Gall-bladder.—P, Stomach.—P*, Its pyloric end.—Q, Vena portæ.—R, Vena cava.—S, Common bile-duct.—T, Intestinum cœcum—t, Vermiform appendage.—T* T** T**, Ascending and transverse colon.—U U, Small intestines.—V, Spleen.—2 2, Internal mammary vessels in front of left vagus and phrenic nerves.—3, Cœliac axis.—4, Hepatic superior coronary artery of the stomach.—5, Inferior coronary artery of the stomach formed by branches of the hepatic and splenic arteries.

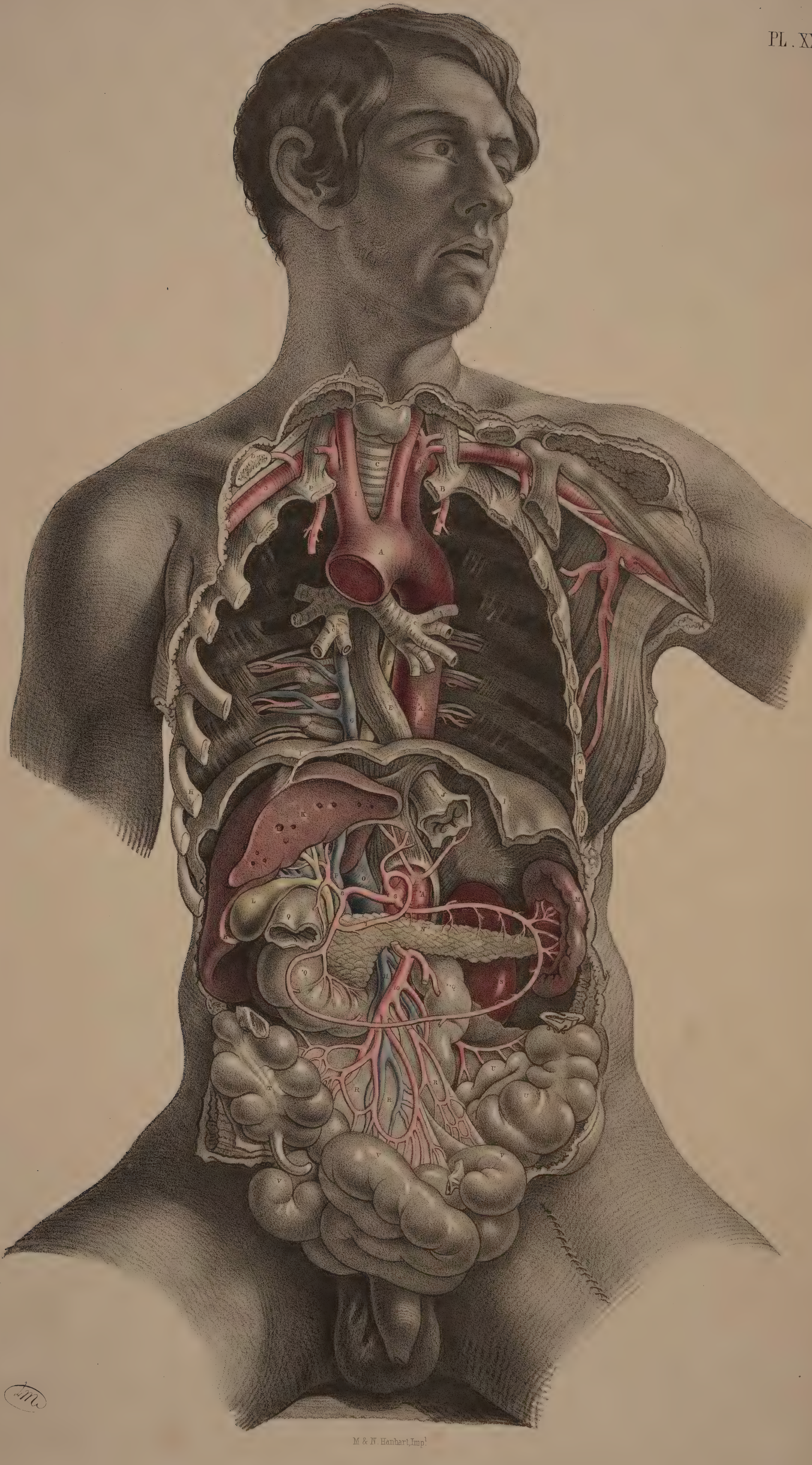
liver is situated here antero-posteriorly and transversely, reaching from the anterior margin of the ribs to the spine, and from the cartilage of the eleventh rib to that of the seventh joining the sternum. In many adults the left lobe of the liver crosses the median line to some considerable distance: in early infancy this is the normal condition: in the primitive stages of fœtal development it touches the spleen in the left hypochondriac recess. Its upper surface is convex, corresponding to the concavity of the diaphragm; its under surface is flattened, and covers the pyloric portion of the stomach and the duodenum. When of its normal proportions it is almost wholly concealed beneath the costo-diaphragmatic roof; its anterior margin alone, for an inch, more or less, being the only part within the cognizance of the practitioner's touch. But when abnormally enlarged, it protrudes considerably from under the ribs into the abdomen below, and at the same time elevates the diaphragm, thereby contracting the right thoracic side. The abdominal protrusion of the liver may, however, exist without being proof of its diseased state, for it may be pressed downwards either by an effusion into the pleura, or by an emphysematous lung. On the other hand, when actually enlarged, it may, instead of revealing itself in a downward situation, elevate itself to even a level with the fifth or sixth rib, pushing the base of the right lung to that height, and then, while percussion elicits a dull sound over this place, such sound may be mistaken for a hepatized lung. On deep-drawn inspiration the lung descends with the diaphragm, and both push the liver from under the ribs more than usual, and then percussion at the anterior thoracic base yields a sound more pulmonary than hepatic. After extreme expiration, when the lung with the diaphragm has ascended, the liver likewise is drawn up more under the ribs than usual, and now percussion over the same part yields a sound more hepatic than pulmonary. The state of the liver can always be ascertained more exactly before than behind, for in the latter situation there intervenes a much greater thickness of parts between it and the surface.

The *stomach* is situated transversely between the margins of the opposite false ribs, and occupies the interval between the sternum and the umbilicus. On the right side the liver partially overlaps it, but at the epigastrium and left hypochondrium it is immediately beneath the anterior parietes. Its upper or smaller curve is turned towards and close to the diaphragm, which transmits the œsophagus at its centre; the lower or greater curve of the stomach is in contact with the transverse colon from the right to the left hypochondrium. To bring in view this part of the colon and the small intestines it is necessary to detach the omentum from the lower curve of the stomach. The left or greater end of the stomach is under cover of the left false ribs, and is separated from the diaphragm by the spleen. The right or lesser end of the stomach and the duodenum are separated from the diaphragm by the liver. The œsophageal end of the stomach is more deeply situated than its pyloric end. The stomach, whether empty or full, does not change those relations, but in the latter condition it occupies greater space in the abdomen; and then, to admit of its increased volume, the anterior parietes relax. When percussion is made from the cardiac and hepatic regions to that of the stomach and intestines, the flat sound elicited at the two former places is changed to a hollow sound in the latter. A distended stomach is in some degree an impediment to the action of the diaphragm and to free respiration; the aorta and vena cava behind it must suffer pressure from it; and it is also true that the heart's free action, which is so dependent upon free respiration, must, in this state of the stomach, be impeded. To those circumstances combined may be ascribed the disposition to somnolency *post plenum prandium* in all animals of that habit of diet.

The *spleen*, when of its normal proportions, is of the size of a kidney, and somewhat of the form of that organ. It lies deeply in the left hypochondrium, between the diaphragm and adjacent bulging end of the stomach. To bring the spleen in view it is necessary to draw the stomach from the left subcostal recess. The spleen is attached to the bulging end of the stomach by a mesentery, in which are the vasa brevia of the splenic artery. The pancreas may, at the same time, be seen reaching transversely from the spleen to the duodenum, and situated behind the cardiac end and superior curve of the stomach. The spleen is liable to extraordinary increase of size, especially in those who have been for a long period the subjects of ague. In such individuals the spleen has been found so large as to have dislocated the stomach from the subcostal recess; depressed the left kidney to the iliac fossa, and elevated the diaphragm on its own side to a level with the fifth rib. In that condition the spleen impedes respiration on its own side in the degree that it contracts thoracic space, and from its presence in such unusual positions its form and size can be readily discerned by percussion. When the spleen is thus enlarged it projects from under the false ribs towards the epigastric region, like an enlarged liver, and, both organs being of the same colour, adds to their similitude. While we find that every lateral organ of the body, except the spleen and the liver, has its opposite counterpart, would not this seem to express (there being in nature no exceptions to her *universal* law) that those two organs refer to each other in form, if not in function?

The *intestinal canal*, consisting of the duodenum, jejunum, ileum, and colon, occupies the lower two-thirds of the abdominal chamber. The duodenum and jejunum lie deeply under cover of the stomach; the ileum and colon float in contact with the anterior abdominal walls. The mobility of all those parts allows their relative position to be examined without further dissection. On elevating the forepart of the liver, and parting the gastro-hepatic mesentery, we find the duodenum, in shape resembling the stomach, but bending in a contrary direction to that organ, that is from right to left, and at the same time backwards and downwards. In the curve of the duodenum appears the head of the pancreas, whose duct, and also that of the liver, it here receives. On raising the stomach and colon, and tracing the continuity of the duodenum and jejunum across the spine and the great bloodvessels, we notice the root of the superior mesenteric artery, which, passing in front, serves as an artificial mark between those portions of the bowel. From the commencement of the ileum in the jejunum to its termination in the cœcum, the convolutions of the small intestine allow of being unfolded, and the form of the mesentery examined. The mesentery is plicated according as the intestine is convoluted. Its posterior border, which is attached to the spine beneath the meso-colon, extends only from the second lumbar vertebra to the right iliac fossa, while its anterior border equals in length that of the small intestine. Hence it is that the folds of the mesentery are deeper in front than behind; and from this disposition of the part it results that, not only are its principal offices of being a bed for the numerous bloodvessels, lacteals, and glands, and a suspensory bond for the intestine well served, but space is economised, and the vermicular motion capable of being performed as freely as if the bowel floated free and unattached by it. The same remarks apply to the meso-colon. The cœcum is fixed in the right iliac fossa by the peritonæum, which invests only its forepart in some individuals; in others it is loose in this situation, and covered entirely by the membrane, which then forms a kind of mesentery for it. In the latter cases a hernial protrusion of the part is possible. The cœcum is covered anteriorly by the convolutions of the small intestines in part; and it is partly also in contact with the abdominal parietes at the outer half of Poupart's ligament. During life a gurgling sound is perceptible in the situation of the cœcum, and is caused by the passage of the intestinal matter into it through the ileo-cœcal valve. From its cœcal origin the colon ascends the right loin as high as the liver, and is here overlaid by the gall bladder; from this place the colon crosses the abdomen immediately below the stomach, following the inferior curve of that viscus as far as the left hypochondrium, where it sinks back, and, becoming bent upon itself, descends to the left iliac fossa. In the latter place it forms the sigmoid flexure, under cover of the small intestine, and thence descends the pelvis between the bladder and sacrum, as the rectum intestinum. The sigmoid flexure lies loose in the left iliac fossa, owing to the free portion of the meso-colon by which it is attached to the spine. It appears, in some instances, formed of such ample folds, as in part to occupy the pelvis. It rests on the left ureter, the external iliac, and the spermatic vessels. Its looseness will explain why it is occasionally found to form part of the contents of an inguinal hernia.

Having examined the general relations of the principal viscera of the trunk, the parts which next claim attention are the vessels and nerves which supply them. In order to bring in view the vessels, we have to remove the viscera in the following manner:—The heart and lungs are to be wholly taken from the thorax; the anterior half of the diaphragm is to be cut away; the stomach is to be divided at its œsophageal and pyloric ends; and the whole intestinal canal, to the sigmoid flexure, to be separated from the mesentery. The liver is to be divided at its transverse fissure, and the forepart removed. While this is being done, the visceral arteries and veins in the several mesenteries, and the vena portæ, may be noticed; and the symmetry of the vascular centres, and their branches, will likewise strike attention, as they range along the spine. The arterial system of vessels assumes, in all cases, somewhat of the character of the forms upon which they ramify. This mode of distribution becomes the more apparent, according as we rise from particulars to take a view of the whole. With the same ease that any piece of the osseous fabric, taken separately, may be known, so may any one artery or vein, apart from the rest, be distinguished as to the place which it occupied, and the organ which it supplied. The vascular skeleton conforms most with the osseous.



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COMMENTARY ON PLATES XXI. XXII. XXIII. XXIV. & XXV.

The *aorta*, like the spinal column, is central and common to both the thorax and the abdomen; it is the one thoracico-abdominal main vessel, and calls for a comparison, not only of its several parts, but of all the branches which spring from it. The aorta arises from the left ventricle on a level with the fourth dorsal vertebra and the middle of the sternum, and descends the thorax on the left side of the spine, and the abdomen on the forepart of the spine, and terminates on the body of the fourth lumbar vertebra. In the thorax the aorta has the œsophagus, thoracic duct, and vena azygos on its right side. The four parts, and the nerves accompanying them, are between the laminæ of the mediastinum. Throughout its extent the exact symmetry of the aorta is as apparent as that of the skeleton. As the ribs and lumbar transverse processes jut symmetrically from either side of the spinal column, so do the intercostal and lumbar arteries from the sides of the aorta. The visceral branches are moulded according to the froms of the organs. As the thoracic viscera differ in form and number from those of the abdomen, so do the aortic branches, supplying each set, differ likewise in the same respects. In addition to the bilateral symmetry of the aortic system, I would also point to the analogy existing between the primary branches at its arch above, and those into which it bifurcates below. This analogy is as evident as that between the upper and lower limbs, which they supply. On comparing the branches of the aorta given off from both its extremities, we find them, as they appear in their normal character, differing as to number only; thus, while *three* branches—the innominate, the left carotid, and the left subclavian,—spring separately from the arch of the aorta, to supply the head and arms, the aorta, at its lower end, divides into *two* common iliac branches for supplying the pelvis and lower limbs. But when we take into account the varieties which so frequently appear among both sets of branches, we shall find that the principal of them are simply an interchange—viz., that which is the abnormal order of the branches above, representing the normal order of branches below, and *vice versâ*. When, for example, the two left branches of the aortic arch coalesce and appear, like the innominate on the right side, single, then both, as innominate, correspond in form with the two common iliac. When, again, the two common iliac branches are divided immediately after separating from the aorta into two opposite pairs of branches, then these correspond with that abnormal condition of the branches of the arch in which those appear as four in number, from a cleavage, as it were, of the innominate. The veins accompanying both sets of branches are usually identical in form. An innominate condition of the veins above, and a common iliac condition of the veins below, correspond to each other, and would seem to indicate that this is the typical condition for the arteries as well as for the veins.

The aorta is similar as to form in almost all cases, but it frequently varies as to its length, measured in respect to the spine; and hence the length of the branches arising from its ends will, at the same time, vary. From its arch, on a level with the cartilages of the second ribs, to its bifurcation on the fourth lumbar vertebra, the aorta diminishes in caliber according to the number and size of the branches successively given off from it. Its varieties, as to length, depend upon the following circumstances:—When the aorta, springing from the left ventricle at the usual level, describes a shallow arch, it is low in the thorax, and the primary branches are in proportion lengthened. When the aorta forms a deep arch, it is high in the thorax, and then the primary branches are shortened. The length of those branches may vary, even when they are in their usual order, and the aortic arch at its usual level, for the height to which they rise in the neck before dividing will determine their length. When the innominate arises from the middle of the ascending part of the arch, and bifurcates opposite to or above the sterno-clavicular junction, the length of that branch is increased. In the same manner is the length of the aorta and of its branches varied at its lower end. According as the aorta divides above or below the fourth lumbar vertebra, it is itself shortened in the former case, and the common iliacs lengthened; or it is itself lengthened in the latter case, while the common iliacs are shortened. The length of the common iliacs is likewise dependent upon the place at which they bifurcate, though they arise from the aorta at the usual level. The occasional existence of a *sixth* lumbar vertebra will vary the length not only of the aorta itself, but of the iliac branches.

The abdominal part of the aorta is about a third of the length of the whole vessel. Opposite the last dorsal vertebra the abdominal aorta appears in the span of the pillars of the diaphragm, and terminates in front of the body of the fourth lumbar vertebra. From this short part of the aorta arise all the branches which supply the abdominal viscera. Compared with the visceral branches of the thoracic part of the aorta, those of the abdominal are remarkable for their number and size—a fact readily accounted for when we consider that the latter vessels serve other purposes in the economy, besides that of the support and repair of the structures to which they are distributed. The abdominal branches are large and numerous, in proportion to the great quantity of fluid matter secreted by the glandular apparatus, comprising the gastro-intestinal canal, the liver, pancreas, kidneys, &c. Like the thoracic arteries, between and behind the pleuræ, those of the abdomen traverse this place behind the peritonæum, and between the layers of the several mesenteries. The aorta is behind the peritonæum, and is bound down by this membrane to the lumbar vertebræ; in front of the aorta the mesenteric duplicatures are given off, and here they receive the arteries and branches of the sympathetic nerves, and return the veins to the portal trunk, and the lacteals and lymphatics to the receptaculum chyli. The vessels of the gastro-hepatic mesentery, of the meso-colon, and of the omentum are between the layers of the *two* peritonæal sacs; the vessels of the mesentery are between the layers of the *single* sac which forms it. The branches of the abdominal aorta arise from it, at very short intervals, anteriorly and laterally. The first of the anterior branches are the phrenic arteries, which ramify on the lower surface of the diaphragm, and give offsets to the supra-renal bodies. The second is the cœliac axis, giving off the hepatic, gastric, and splenic. The third is the superior mesenteric, branching in a remarkable looping form to the small intestines, and to the ascending and transverse parts of the colon. The fourth is the inferior mesenteric distributed in a similar form to the descending colon, to its sigmoid flexure, and to the rectum. All the arteries of the gastro-intestinal canal form a chain of anastomoses in the mesentery from beginning to end. The renal arteries arise laterally close to the origin of the superior mesenteric. The spermatic arteries arise either from the aorta, or from the renal arteries. The lumbar arteries arise from the aorta at its posterior aspect, and are in series with the intercostal. The common iliac arteries are in series with, and analogous to, the lumbar. The middle sacral artery, though being the smallest branch of all, is the true termination of the aorta; and as such, is single and central on the bodies of the sacral and coccygeal vertebræ. The two common iliac arteries diverging from each other bifurcate respectively on the sacro-iliac junction into the internal iliac branch which supplies the pelvic organs, and the external iliac which passes along the brim of the true pelvis to the middle of Poupart's ligament, where it gives off the circumflex-iliac branch to course as its name indicates, and the epigastric branch which ascends the anterior abdominal wall between the peritonæum and the rectus muscle, in the direction of the umbilicus. The two common iliac veins receiving the external and internal iliac branches between the corresponding arteries, join and pass beneath the upper part of the common iliac artery, to form the vena cava, which ascends on the right of the aorta, and, after receiving the right renal vein on its own side, and the left renal vein, crossing to it in front of the aorta, is joined by the hepatic veins issuing from the posterior part of the liver, and finally enters the right auricle through the foramen quadratum of the diaphragm.

The *kidneys* are situated in the loins, opposite to each other, and behind the peritonæum. They are usually embedded in a large mass of adipose substance. They lie in front of the last ribs and the quadrati lumborum muscles. The right kidney is in contact by its upper part with the liver, and by its lower part with the cœcum; the duodenum and ascending colon touch its forepart. The left kidney is in contact with the spleen above, and with the sigmoid flexure of the colon below; the jejunum and the descending colon lie in front of it. Both kidneys

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FIGURES OF PLATE XXIII.

A A* A**, Thoracic and abdominal aorta.—B B, First ribs.—C, Trachea.—C C, Bronchi.—D D, Clavicles cut.—E. Œsophagus—F. Thoracic duct.—G, Vena azygos and right intercostal veins.—H H, Seventh pair of ribs.—I I, Diaphragm cut transversely.—J, Œsophageal end of stomach.—K K, Liver in section.—L l, Gall-bladder and duct.—M, Spleen.—N. Pancreas.—O, Vena cava inferior.—P, Vena portæ.—Q, Pyloric end of stomach.—Q*, Duodenum.—Q**, Jejunum.—R R R, Mesentery.—S, Left kidney.—T, Caput coli—U U, Sigmoid flexure of colon.—V V, Convolutions of small intestines.—1, Innominate artery.—2, Left carotid artery.—3 3, Right and left subclavian arteries.—4, Internal mammary artery.—5, Intercostal artery.—6, Cœliac axis.—7 7, Superior and inferior coronary arteries of stomach.—8, Hepatic artery.—9, Splenic artery.—10, Superior mesenteric artery.—11, Mesenteric vein.

are liable to dislocation from their natural position—the right one by an enlarging liver, the left by an enlarging spleen, in which case either may be depressed as low as the iliac fossa. Each kidney is oval and smooth at adult age, but often throughout life it exhibits traces of its early lobulated condition, which is permanent in the lower animals. On its inner border the kidney presents a fissure to receive the artery and vein, and to give exit to the ureter—its excretory duct, which commences by a dilated part, called the pelvis of the kidney, in front of the vessels, and thence descends behind the peritonæum over the bifurcation of the common iliac arteries to the bladder in the pelvis. The ureter is more adherent to the peritonæum than is any of the vessels; and hence, by raising the membrane, it will always be found to follow. On the summit of each kidney lies the *supra-renal capsule*, which conforms with the shape of the kidney, as if it were a part of this gland, but it is not. In the early fœtal state we find the supra-renal capsule as part of the entirety named the Wolfian body; but whether or not at that time it has a use, none has hitherto been reasonably assigned to it at the adult period; for, though glandular, like the kidney, from all appearance of structure, it is devoid of an excretory duct. Is it a lymphatic body? Whatever be its function, if it have any, it seems to me not much more a mystery than the kidney itself is, though knowing the latter to be a true gland, in every sense of that term. The anatomical condition of the kidney, and also its physiological use, are alike peculiar, when we compare it to the lung or the liver. The latter organs, as glands, are traversed by arteries destined to support their respective tissues, and by other vessels specially serving to convey to each of them *carboniferous blood*, the effete matter of which they separate and cast off. The kidney, on the contrary, is supplied direct from the aorta with a *single* artery, conducting pure *oxygenated blood* for the support of its own tissue, and also for having eliminated from that blood (which is fit to circulate through the gland of thought—the brain itself) *a fluid—the urine*—which is of so absolutely excrementitious a composition, that as soon as it is formed it is forthwith voided from the body. A renal vein, nevertheless, returns the blood, thus deprived of *urinous* ingredients, and that blood is, to all appearance, still the same as the blood of the other systemic veins.

A knowledge of the relative position of the thoracic and abdominal organs enables us to account for certain pathological phenomena, which, however, we possess as yet but little skill to remedy. Thus, it would appear most probable, that many cases of ascites and anasarca are more frequently caused by a mechanical obstruction of the bloodvessels than by what we are taught to be "a want of balance between secreting and absorbing surfaces." A stone in the gall-duct is known to give rise to jaundice, by hindering the entry of bile into the duodenum. An abscess, or other tumour of the liver, may, by compressing the vena portæ, or the inferior vena cava, cause serous effusion into the peritonæum in the former case, and anasarca of the lower limbs in the latter case. In ascites the liver is generally morbidly enlarged. Matter accumulating in the sigmoid flexure of the colon may cause a hydrocele or a varicocele, by pressure on the spermatic vessels. It is quite true that these two latter affections happen more frequently on the left than on the right side; and therefore it seems to me more reasonable to attribute them to the circumstance stated, than, as some do, to the fact of the left spermatic veins opening into the left renal vein at a disadvantageous angle. An aneurism of the aorta, or innominate artery, pressing on the neighbouring veins, causes œdema of the face and arm; if it obstruct the pulmonary veins, the lungs become congested. If the cardiac veins be compressed by the hypertrophied substance of the heart, effusion into the pericardium is the consequence; and if this sac be much distended, the fluid, compressing the flaccid auricles and the roots of the venæ cavæ, will give rise to general anasarca, to hydrothorax, or to ascites, either separate or co-existing. Scrofulous bronchial, or mesenteric lymphatic bodies, may cause the same results. Tumours of the liver are more common than those of the spleen; and as the former organ has the vena portæ and hepatic artery entering its transverse fissure, the vena cava passing through a sulcus in its thick posterior border, and the gall-ducts issuing from it, the cause of ascites, as well as jaundice, should be sought in reference to those circumstances. When an abscess forms in the liver, it will, according to the direction in which it points, void itself either into the thorax, or through the side between or beneath the false ribs, or into the stomach, the duodenum, or the transverse colon, which organs are in contact with its under surface. The contiguity of the liver and stomach to the diaphragm accounts for the "gastric" and "hepatic cough," when those organs are inflamed; the irritation being either directly communicated to the muscle from them, or being the result of reflex nervous influence. When large biliary concretions form in the gall-ducts, nature, failing in her efforts to discharge them by those passages, sets up inflammation and ulcerative absorption, by which processes they gain a passage to some part of the neighbouring bowel, either the duodenum or the colon. In those processes the part in which the stone has been formed becomes soldered by effused lymph to the bowel, and thus the stone is prevented escaping into the peritonæum. When the bowel is wounded, the part, in fortunate cases, is rendered, in the same manner, adherent to the abdominal parietes, and the intestinal matter is thereby prevented entering the peritonæum; or the bowel adheres to the lips of the external opening, and through this the matter is discharged. The operation for artificial anus is founded on the same principle.

In cases in which the abdomen becomes so enormously distended by effused serum, that it appears not more hopeless to void it by the free use of our medicinal diuretics and hydragogue cathartics, than it is to account for the condition by any fault of the serous membrane *per se*, then paracentesis by the instrumental hydragogue, viz., the trocar and canula, is reasonably demanded. In performing this operation the following facts are to be remembered:—Fluid occupying any of the cavities of the body gravitates to the most depending part, and, therefore, as in the sitting or standing posture the fluid of ascites will fall upon the median line between the umbilicus and the pubes, this is the line in which the puncture should be made. In the female, the ovary is frequently the seat of dropsical accumulation to such an extent as to distend the abdomen like ascites, and render the diagnosis doubtful. Ovarian dropsy is distinguished from ascites by the particular form and situation of the swelling. In ascites the abdominal swell is symmetrical while the body is erect. In ovarian dropsy the tumour is greatest on either side of the median line, according as the affected ovary happens to be the right or left one. The fluid in both cases affects the position of the viscera differently. In ascites the fluid gravitates to whichever side the body is inclined; it floats the moveable organs to the opposite side; and it then occupies space between those organs and the parietes. The ovarian tumour is, on the contrary, comparatively fixed to its place; it permanently displaces the intestines on its own side; its sac lies in contact with the parietes; and neither itself nor the intestines will change position according to the line of gravitation. Those circumstances, however, though serving to distinguish both forms of dropsy, do not affect the propriety of choosing the site for the operation at the place specified; for, though the peritonæal fluid displaces the moveable viscera, it does not influence those which are fixed, viz., the liver, the stomach, the spleen, and the kidneys. Whether the dropsy be peritonæal or ovarian, it may be most safely voided at the linea alba, below the umbilicus, midway between this point and the pubes. At this situation the epigastric artery may be avoided; here no important viscus is to be found; and here the fluid gravitating comes next to the abdominal wall, and interposes itself between that part and the small intestines, which cannot approach the point of the instrument nearer than the length which their mesentery allows. Having made the puncture, it becomes of the utmost importance not to urge the evacuation of the fluid by manual compression, but to let it flow in the measure in which the resilient abdominal parietes will allow it, and no more. The state of syncope, sometimes fatal, which follows complete evacuation, is owing to the bloodvessels of the abdomen having lost that support which for a considerable time the presence of the fluid gave them, and to which their circulation accommodated itself. The abdominal plexuses of the sympathetic nerves are also affected by that change; and when it is recollected how lax the parietes must be after previous tension, it will be evident that they cannot accommodate themselves to the abdominal organs, when the fluid is suddenly and entirely voided. In pregnancy the abdominal parietes are in the same manner stretched and elongated; but in parturition, after the exclusion of the fœtus, the solid mass of the uterus remains to be reduced in volume by the slow process of absorption; and in the interval those parietes as slowly regain their original form and dimensions.

The abdomen, owing to the absence of osseous parts in its parietes, is more exposed than the thorax to penetrating wounds; but from the pliability of its walls, which allow of the thorax and pelvis to approach almost in contact with each other in the various anterior flexures of the body, it secures in some respects its own defence. The physical influences which result from wounds of the thorax as a pneumatical apparatus, do not attend wounds of the abdomen: when air enters or blood is effused in the thorax, respiration is impeded, for the rigid walls of that cavity being incapable of accommodating themselves to the surplus matter, cause this to compress the viscera; but the abdominal walls are so dilatable that fluid becoming effused in their cavity to the greatest extent will not, while it is diffused generally through the inter-

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stices of the viscera, interfere with the functions of these. The lungs are so constituted in respect to the thorax, that it is not possible for a sharp-pointed instrument to enter the costal pleura without wounding the lungs, which are in as close apposition with that membrane as if both were structurally joined. To this circumstance is to be ascribed the chief danger from thoracic wounds. If it were possible that in such accidents the pleura alone suffered simple lesion, surely, judging from the anatomical nature of that membrane, there can be no reason why it should be attended with worse consequence than the like injury to the integument. The same remark (if true) must apply to wounds of the peritonæum—a membrane in all respects similar to the pleura. But unlike the lungs in relation to the thorax, the intestines in relation to the abdomen are of that form which may admit of an instrument penetrating the peritonæum without themselves being involved; and these are the cases which, often to the surprise of the surgeon, recover. The intestines owing to their mobility, their form, their membranous structure, their hollowness and their compressibility, are so readily detachable from the walls of the abdomen, that they yield before the edge of the sharpest instrument, if this do not enter the peritoneal lining beyond a certain degree. Moreover, it is possible for the instrument to pass into the abdomen for even an inch or two between the convolutions of the intestines without injury to them. In their state of distension, however, this immunity from danger in those accidents is much lessened, and particularly so in regard to the stomach. In judging of the extent of visceral injury from abdominal wounds, the thickness of the parietes and of the omentum should be taken into account, for in different subjects the quantity of adipose substance in both parts greatly varies. The way in which the instrument has passed should also be considered, for *direct* penetration, though to a less degree, may wound the viscera more certainly than *oblique* penetration to a much greater extent. The fatality which so often results from abdominal wounds may be ascribed in most cases, if not in all, to a division of the coats of the bowel or stomach, followed by extravasation of the intestinal matter, or to a wound of one or other of the solid vascular organs. For as to the danger incurred by simply incising the peritonæum, the operative measures undertaken, and necessarily involving that membrane, sufficiently show that this is a question which still and for ever may be left without much loss under debate with those pathologists of the infinitesimals who would essay to diagnose by the pulse between inflammation of either of the three coats of the bowel, and thereupon ply their pharmacy. While we see how gored dogs with their numbles (otherwise uninjured) trailing the ground, yet recover, (and who shall say that between their organization and our own there exists the difference even of a gossamer?) we may well agree that to other causes than the opening of a hernial sac the supposed danger of that occurrence is due.

The position of the external wound does not in all cases indicate with certainty which organ of the abdomen has been injured, if any have been. The direction in which the instrument has penetrated can alone determine this. But if the body be transfixed, then the line between the two wounds being straight, tells of the organs through which the instrument must have passed. If a small sword transfix the body through the middle of the seventh or eighth intercostal spaces, it will enter the base of the thorax on both sides, and the summit of the abdomen in the middle: the organs which will have been wounded in that course are the opposite lungs, with the liver and stomach between them, and also the spleen, if this happen to be larger than usual. If that instrument pass through the body from any point between the xiphoid cartilage and the umbilicus to the tenth or eleventh dorsal vertebra, it will traverse the stomach in the abdomen, and enter the thorax at its posterior middle line, where the great vascular trunks are situated; but if the point pass on either side of the spinal column, then the pleura and lung will be injured. From this the relative forms of the thorax and abdomen may be known. The correspondence of the external wound to the place of any other of the abdominal organs will, when taken with the symptoms peculiar to the lesion of that organ, indicate which is the one that has suffered injury.

The abdominal aorta has in a few instances been the subject of deligation; and truly, those must have been such extreme cases, to call for the operation, that to tie the aorta in the thorax would seem but little less justifiable. To arrest the circulation in a vessel that supports one-half the body, must indeed be a last experiment in surgery, notwithstanding that our anatomical knowledge would appear to give us hope of success from the measure. So many and such large branches arise from the abdominal aorta, and these are set so closely together, that if it be true that such a condition is unfavourable to the operation, the objection is in full force in all instances. But, then, it is from that very condition of the branches that we may judge of the possibility of a collateral circulation being maintained after the ligature is applied. When for an aneurism involving the common iliac artery, the abdominal aorta is tied at a point between the origins of the superior and inferior mesenteric branches, where it would be *below* the renal arteries, the direct circulation must then be arrested in and around the pelvis and its organs, and also in respect to both the lower extremities. To supply this want, the principal of the anastomosing branches are these:—the internal mammary and intercostal arteries, with each other in the thoracic, and with the epigastric and lumbar arteries in the anterior abdominal parietes—the superior and inferior mesenteric arteries with each other in the left part of the meso-colon; and the descending branches of the latter vessel with those supplying the rectum from the internal iliac and the pudic—the lumbar branches, with the ilio-lumbar, from the internal iliac; and the latter with the circumflex ilii and the gluteal around the hip-bone. The spermatic arteries are of no account in regard to anastomosis, for they terminate in the testicles, and are there isolated; but in the female the corresponding arteries supplying the ovaries anastomose with those of the uterus. Now, considering that these are the only channels for carrying on the circulation through the lower half of the body, and that even the amount of their anastomosis, above-mentioned, is not to be calculated upon as invariable in all cases; and considering, moreover, the formidable nature of the measure necessary for reaching the aorta at the back of the abdomen, behind all the viscera, it may, I think, be fairly said that the surgeon who would attempt this operation with any expectation of a successful result, officiates only as the ready minister of Fate by severing the vital cord, which is already being stretched to cracking from both its ends. The operation has been tried in two ways:—one, by an incision through the anterior median line at the umbilicus, opposite which the aorta bifurcates; the other by an incision in the iliac region. Of the two methods, anatomically considered, the former would seem preferable for these reasons: 1st, The aorta, borne forwards by the lumbar vertebræ, comes closer to the anterior parietes than it ever does to the crest of the iliac bone. 2nd, The parietal peritonæum needs only to be simply divided along the linea alba, to allow of the small intestines being unrolled and the root of the mesentery reached, where this part is attached to the aorta; whereas by the iliac incision it becomes necessary to lift and separate from its supporting capillary vessels the peritonæum, to an extent reaching from the iliac crest to the lumbar vertebræ—a measure which, in order to maintain the *integrity* of the membrane, must deprive it of its *vitality*.

The common iliac artery has several times been tied (in a few cases with a degree of success sufficient to warrant future trials) for a wound of itself, and for an aneurism of the external or internal iliac branches. The common iliac occupies a position scarcely less accessible than the aorta, and as it requires the same dissection of parts to reach it, the fact of the operation being promising in respect to the iliac vessel, and not to the aorta, must be due to the form of the iliac, and particularly to the circumstance of the direct circulation, when arrested in it, affecting only one half the pelvis, and its organs and one limb. The usual length of this vessel is from the middle of the fourth lumbar vertebra to the sacro-iliac junction; but its length varies, as already mentioned, according to the place at which the aorta or itself bifurcates. Whatever be its length, it seldom or never gives off branches, but it is so complicated (especially the right one) with its accompanying large veins, as to cause a difficulty

FIGURES OF PLATE XXIV.

A A* A**, Thoracic and abdominal aorta.—B B, First ribs.—C C, Second ribs.—D D, Clavicles cut.—E, Sterno-mastoid muscles cut.—F F, Pectoralis major muscle cut.—G G, Pectoralis minor muscle cut.—H, Thyroid body.—I I, Fourth ribs.—J J, Fifth ribs.—K, Dorsal spinal column.—L, Xiphoid cartilage.—M M, Seventh ribs.—N N, Tenth ribs.—O O, Right and left kidneys.—P P, Supra-renal capsules.—Q, Pillars of the diaphragm.—R R, Lumbar muscular parietes cut.—S, Right iliac fossa.—T, Urinary bladder.—U U U*, Sigmoid flexure of colon and the rectum.—V V, Ureters. W, Spinous process of right iliac bone.—X X, Vasa deferentia.—Y, Right psoas muscle. Z, Symphysis pubis.—1 1, Coronary arteries of heart.—2, Innominate artery.—3, Left carotid artery.—4 4 4, Subclavian arteries.—5, Right carotid artery.—6, Right internal jugular vein cut.—7, Subclavian veins cut.—8, Bronchial arteries.—9 9, Intercostal arteries.—10, Cœliac axis cut.—11, Superior mesenteric artery cut.—12, Renal arteries.—13, Inferior mesenteric artery.—14, Inferior vena cava.—15, Common iliac arteries.—16, Common iliac veins.—17, Internal iliac arteries.—18, External iliac arteries.—19, External iliac veins.—20, Epigastric artery in connexion with the spermatic artery and vas deferens.

in insulating it from them. It is invested almost completely by the peritonæum, which, adhering closely to it, may be regarded as its outer coat. The right artery has its vein close to its inner side. The left artery has its vein separating from it to join the opposite vein, under the root of the right artery, where the two veins form the commencement of the vena cava. Each artery ranges along the inner border of the psoas muscle, which is more bulky and prominent in some individuals than in others. The lumbar nerves, which form the anterior crural nerve, are embedded in the psoas muscle, and not in connexion with the vessels. The ureter descends loose and flexuous upon the psoas and behind the peritonæum to the point of bifurcation of the common iliac artery, and here passes over it to the bladder in the pelvis. When, by a ligature, the circulation is arrested in the common iliac artery, there are (besides the anastomosing branches, named in regard to deligation of the aorta) the branches of the vessels of opposite sides communicating freely with each other in and around the pelvis, and in the substance of the pelvic viscera. All the branches of the internal iliac arteries inosculating on the rectum, the bladder, and across the perinæum, and (in the female) on the uterus, are then in full force for the support of the parts on the distal side of the ligature; and hence it is that, though the common iliac artery is but little less in caliber than the end of the aorta, the successful issue of the operation on the former vessel is more likely to be realized. The amount of anastomosis is not affected by any of the anomalous forms of either vessel.* The incision which is recommended for exposing the common iliac in the operation, is one which commences about two inches above the iliac spinous process, and being carried parallel with, but an inch above the outer third of Poupart's ligament, terminates opposite the middle of the inguinal fold. The muscular substance of the three abdominal muscles, together with the transversalis fascia, will here have to be successively divided, and after this the peritonæum will have to be raised from the iliac fascia over the iliacus muscle, and also from the psoas muscle. The membrane as readily admits of this proceeding in the living as in the dead subject, and carries with it the ureter and the spermatic vessels. As it is the peritonæum which fixes the cœcum to the iliac fossa, that gut must of course be detached from its seat with the membrane; and this certainly must be a matter of no trifling moment. Besides this, considering the depth of the artery from the external opening, and the great difficulty of reaching it beneath the incumbent weight of the bowels, it would seem to be the more ready mode, and certainly not a more dangerous one, to expose the vessel either from an incision at the umbilicus, as is recommended for tying the aorta, or at the linea semilunaris, which is opposite to it. For I hold it to stand for reason, that so long as it remains unproved that opening the peritonæum is the cause of all, or of any of the principal evils supposed to attend that occurrence, a simple incision of it cannot be productive of such ill consequence as peeling a large tract of it from the surfaces of its support. However this may be, as the abdomen is the arena for 'heroic' operative surgery, the two following operations may in this place have a brief anatomical notice.

Hysterotomy and ovariotomy are two operations which cannot be performed without extensively incising the peritonæal sac. The uterus and its appendages the ovaries are completely invested by the peritonæum in their natural state. When either of those organs becomes enlarged, it takes from the peritonæum a covering the measure of its own proportions, just in the manner of all the other abdominal viscera. The gravid uterus and the enlarged ovary occupy abdominal space at the expense of the other viscera, which they displace from their original position; but this is compensated for by the anterior parietes of the abdomen, which become not only relaxed and stretched so as to allow of the anterior bulge, but are actually elongated by superadded structure. The uterus occupying originally a median position in the pelvis, where it has the bladder before it and the rectum behind it, rises from out of the pelvis according as it increases with its contents, and takes a median position also in the abdomen, having its own mesial line corresponding exactly with the linea alba, close to which it lies, and displaces the small intestines by its summit upwards, and equally to either side of it. In this natural periodical process of increase, the uterus but imitates the development of all the abdominal organs in respect to the serous sac which covers them; it brings itself in close apposition with the parietes; but the touching visceral and parietal parts of the peritonæum are (under a prospective regard for the exigencies of parturition) prevented forming adhesions. The ovary placed laterally in respect to the general median line, still occupies that position throughout all its stages of enlargement, and according as it is the right or the left one, it forces the moveable viscera from its own side to the opposite. In some instances the ovarian sac has been found of such large dimensions that besides forcing the abdominal parietes anteriorly, it has greatly encroached upon thoracic space by elevating the diaphragm. As the enlargement of the ovary is the result of diseased action, the part is most liable to contract adhesions to all adjacent parts, through the medium of the peritonæal membrane. In this way, the tumour may assume a multicapsular appearance; but whether this be the cause of that form in all instances, or that it results from the dilatation of Graafian vesicles, it is difficult to determine. Regarding the ovary as the analogue of the testicle, the former would appear to be the cause, for we find the hydrocele of the tunica vaginalis occasionally multilocular—a condition evidently due to this circumstance. From the position of the diseased ovary, even while it is of a size not to interfere with respiration, or with the functions of the liver, stomach, &c., it may be judged how much it will interrupt the free circulation of the iliac vessels. The pressure of it (especially when it is formed of solid matter) against those vessels, is the cause why the lower extremities become œdematous, and their veins varicose. If the ovarian tumour be on the right side, it is liable to obstruct the passage of matter into the cœcum, fixed as this part is to the iliac fossa. If the tumour be of the left ovary, it will obstruct the sigmoid flexure of the colon or the rectum, and thus produce, in either case, that obstinate costiveness which all the purgatives of the pharmacopœia cannot obviate.

The operation of excising the ovary is admissible only in such cases as when it appears to be a circumscribed moveable tumour, with *solid* parietes. If it be a mere *membranous* cyst of large dimensions, and extensively adherent to surrounding parts, it would no more admit of extirpation with safety to important organs, than would the peritonæal sac for an ascites. The incision through the abdomen, for exposing the ovary or the uterus, is recommended to be made along the *linea alba*. This situation will be at once seen to be the one best suited for hysterotomy; for the middle line of the uterus, along which that organ is to be incised, rests immediately against the linea alba, and it is at the middle both of the abdomen and of the organ that the fewest and smallest of the blood-vessels course. The two epigastric arteries ascending behind the recti muscles do not largely communicate across the middle line; and the same may be said of the opposite uterine arteries, arising from the internal iliac; and the ovarian arteries, from the aorta. But with regard to ovariotomy, the incision, if made along the *linea semilunaris*, would better enable the operator to bring in view the ovary, and safely unseat it from the iliac fossa, and disconnect it from other organs. If, for this purpose, a lateral transverse incision were needed, it would coincide with the direction of the fibres of the broad lateral muscles. In this place, however, the epigastric artery would be exposed to danger, if the incision were carried near Poupart's ligament; but perhaps it is needless in this operation to notice so trivial an evil as hæmorrhage from an artery of this size, with the abdomen opened, and every facility for securing the vessel at hand.

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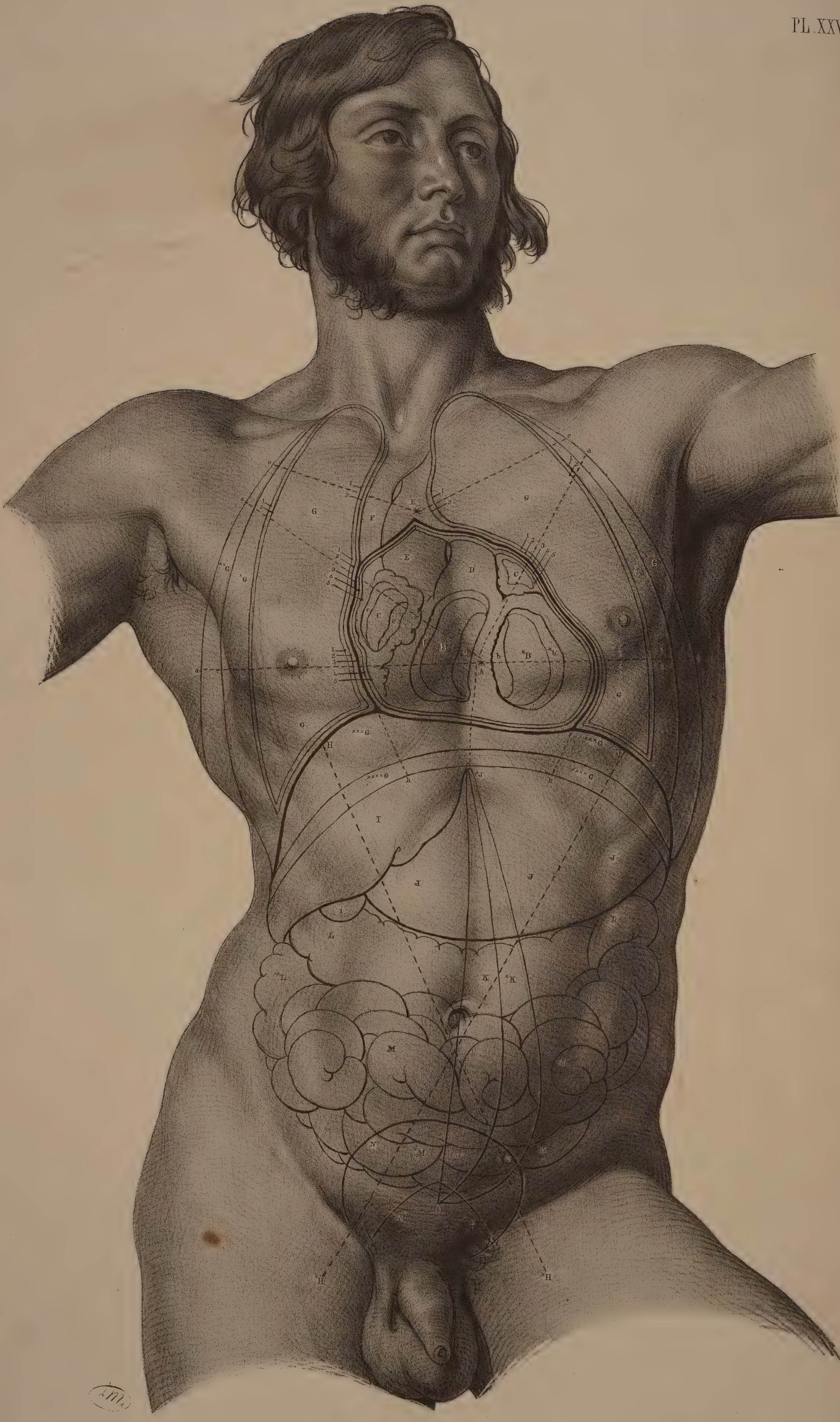
* Whatever may be the number and kind of variations to which the branches arising from both extremes of the aorta are liable, all anatomists admit that the arrangement of these vessels as exhibited in Plates XXIII. & XXIV. is by far the most frequent. The surgical anatomist, therefore, when planning his operation in reference to them takes this arrangement as the standard type. Haller asserts this order of the vessels to be so constant, that in *four hundred bodies* which he examined, he found only *one variety*—namely, that in which the left vertebral artery arose from the aorta. Of other varieties described by authors, he observes—"Rara vero hæc omnia esse si dixero cum quadringenta nunc cadavera humana dissecuerim, fidem forte inveniam." (Icones Anatom.) This variety is also stated by J. F. Meckel (Handbuch der Mensch Anat.), Soemmerring (De Corp. Hum. Fabrica), Boyer (Tr. d'Anat.) and Mr. Harrison (Surg. Anat. of Art.), to be the most frequent. Tiedemann figures this variety amongst others (Tabulæ Arteriarum). Mr. Quain regards as the most frequent change which occurs in the number of the branches of the aortic arch, "that in which the left carotid is derived from the innominate." (Anatomy of the Arteries, &c.) A case is recorded by Petsche (quoted in Haller), in which he states the bifurcation of the aorta to have taken place at the origin of the renal arteries: (query) are we to suppose that the renal arteries arose at their usual position? Cruveilhier records a case (Anat. Descript.) in which the right common iliac was wanting, in consequence of having divided at the aorta into the internal and external iliac branches. Whether the knowledge of these and numerous other varieties of the arterial system be of much "practical" import to the surgeon, he will determine for himself. To the scientific anatomist, it must appear that the main object in regard to them is to submit them to a strict analogical reasoning, so as to demonstrate the operation of that law which has produced them. To this end I have pointed to that analogy which exists between the vessels arising from both extremities of the aorta. With the same view, and in the hope of lightening this dull and weary detail of mere description, I have (under the guidance of the laws of symmetry and serial homology) made brief mention of the similitude which comparison showed me to exist between other parts of the body. "Itaque convertenda plane est opera ad inquirendas et notandas rerum similitudines et analoga tam integralibus quam partibus; illæ enim sunt, quæ naturam uniunt, et constituere scientias incipiunt." "Natura enim non nisi parendo vincitur; et quod in contemplatione instar causæ est; id in operatione instar regulæ est." (Novum Organum Scientiarum, Aph. xxvii, xxviii., lib. i.)



M. & N. Hanhart. Imp.

The mechanism of the thoracico-abdominal apparatus can only be fully appreciated by considering that apparatus and its contained organs as a whole. The correllation of the several parts of its parietes and of the organs to those parietes and to each other, invite to this view. The action of a part is not originated in that part *per se* without the consent of other parts. The act is a reciprocating *nisus* of two or more parts, and so is it with respect to the function of an organ. The organ is functional as much by reason of its relationship to other organs as by its own special form and structure. In the *allocation* of organs, therefore, no less than in their presential respective characters, is design visible. If an organ, functional as it is, would be inoperative in any other situation than that which it normally occupies, it follows that its function is mainly dependent upon the relative position which it naturally has. In that position of it a final cause is expressed as plainly as in its other conditions. And just as in the word *phenomenon*, the orthography is essential to the meaning of that word, and the disarrangement of its letters is annihilative of its meaning, so is there a meaning in the disposition of the parts and organs of the thoracico-abdominal trunk, which, unless contemplated in this light, we fail to understand as much as the body itself would fail to enjoy the result, if that disposition of the visceral letters of the organic word or form were otherwise than what obtains. Form as it is normally is form as it has been fittingly created according to a preconceived design to effect certain definite purposes. What those purposes are, the form *as it is*, compared with the form *as it is not*, will best explain, and enable us to trace the creative passages of the artificer.

The trunk of the body is of an elliptical form, the upper end of which is represented by the first sterno-costo-vertebral circle, and the lower end by the bones bounding the pelvic outlet. Its longest vertical diameter is through the median line, its widest transverse diameter is from one hypochondriac region to the other. The thorax is always the compartment above the transverse diameter; the abdomen and pelvis forming together one chamber, are always below it. The diaphragm is situated in a plane corresponding with the backward and downward slope of the false ribs, and divides the thorax from the abdomen. When (not to pass beyond those anatomical conditions which appear sufficient to illustrate the mechanism of the human trunk) we compare all forms which exhibit a thorax, an abdomen, and a pelvis in the order noticed, we find them all exhibiting bilateral symmetry, whether ribs range along their sides from neck to pelvis, or only constitute a thorax above the transverse diameter. The result of this bilateral symmetry is a similarity of action between the opposite sides of the thorax above and those of the abdomen below. When, again, we compare those forms as to their superior (thoracic) and inferior (abdominal) halves, we find that their dissimilarity is owing to the presence or absence of the ribs in the abdominal half, and that according to the degree of degradation of the ribs in this situation from their fully-developed quantities to their smallest, does the degree of the dissimilitude appear. Since, then, in the human form we find no greater difference between a thorax and an abdomen, in respect to costal quantity, than we find between the abdomen of one animal (*Saurian*) and that of another (*Mammalian*), since the human thoracic sternal ribs degenerate serially into the abdominal asternal ribs, and the quantitive difference between costal forms, whether shielding the abdomen or the thorax in all classes of vertebrated animals, is evidently owing alone to metamorphosing degradation,—it hence follows that in respect to the presence or absence of the ribs are the functional differences of a thorax and an abdomen to be ascertained. Upon this fact as a substratum all other facts illustrative of the design will be found to rest, as thus:—We view the thoracico-abdominal apparatus, of the form now noticed, to be indicative not only of the motions which itself can originate, but of those which it can communicate to the several organs contained in it. We see that all parts of the form, from the root of the neck to the perinæum, serve in the respiratory movement. We see that motion to be rhythmical, and the result of two distinct but successional actions,—viz., inspiration and expiration; and we reasonably infer, *à priori*, the existence of two distinct but consentaneous agents to effect it; forasmuch as it is not in the nature of one organic motionary form to be actively contractile and *actively* relaxant. From the fact, therefore, that neither the thorax nor the abdomen can be active in both modes, inspiratory and expiratory, it must follow that whichever of the two actions the one part serves, the other action is due solely to the other part. Since we find the thoracic parietes are evidently inspiratory, then the abdominal parietes must be the agents of expiration, for it is demonstrable anatomically that if the whole trunk from neck to pelvis were *costal*, like a thorax, *expiration* could not be performed; and it is equally clear that if the whole trunk were *non-costal*, like an abdomen, *inspiration* could not be effected. Hence we must regard the whole trunk as the *respiratory* apparatus, although it is the thorax alone which contains the lungs. And hence, while we acknowledge the abdominal form to be necessary to the thoracic for effecting the respiratory motion, and while we see at the same time that each form is in suit with its proper viscera, and the motions of it as a recipient not only obeyed by the received, but the motions of the viscera of one compartment obeyed by those of the other, thus illustrating how from one causative force,—the respiratory, may flow a plurality of effects equal to the number of the organs contained, and various as are their several functions; we the more must marvel at these results, the simpler the means by which they are produced,—viz., a *hiatus* in costal series which is an *abdomen.*

The thorax is constructed to perform but one kind of *active* motion,—viz., *dilatation.* Its contraction depends altogether on its own elasticity, aided by the action of the abdominal muscles. The inspiratory muscles are all thoracic, and cannot, therefore, be expiratory; the expiratory muscles are all abdominal, and this is the natural classification of them. The inspiratory muscles have that action by reason of the *presence* of the costal circles, which are so many levers made to operate on the *vis inertiæ* of the organs embraced by them. The expiratory muscles have their own action in consequence of the *absence* of the costal circles, by which they become depressors of the thorax and compressors of the abdomen and thorax at the same time. In this reciprocating motion of the thorax and abdomen we may see that the action of their respective class of muscles is like that of flexors and extensors, in so much that the contraction of the one class is obeyed by the inaction of the other, while the motions of the diaphragm placed midway between them, answer to both. The diaphragm, when in action, is a muscle of inspiration in respect to the thorax, and of compression in reference to the abdomen. During its passive state, it is altogether under the influence of the muscles of the abdominal parietes, which, by compressing the abdominal viscera, cause it to assume its arched form in following the recoil of the lungs in expiration. In ordinary respiration, the capacity of the thorax is chiefly affected by the action of the diaphragm and abdominal muscles. When the diaphragm acts, it increases thoracic space by becoming tense across the thoracic base; and in order to allow of this, the abdominal parietes relax and yield to the downward motion given by the diaphragm to their contents. In forced respiration the same occurs, but with an increase of thoracic action. Considering, then, the mechanical principle on which the thoracico-abdominal apparatus is constructed, the most prominent feature appears to be that of enabling either half of it, at the expense of the other, to adjust its capacity to such exigence as its own organs impose on it; and the relative position which they have allows of this compensatory action. When the inspiratory thorax gains space from the abdomen by the contraction of the diaphragm, the expiratory abdomen resumes that space

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FIGURE OF PLATE XXV.

Illustrating the action of the thoracico-abdominal apparatus as effecting the motions of the contained viscera.—A*, Septum of the heart at the thoracic centre, as the fixed point whence the opposite lines *a a a a* of inspiratory thoracic traction, radiate to all parts of the thoracic parietes.—B B*, Right and left ventricles expanding from systole b, to diastole b*, according to those lines of traction.—C C, Right and left auricles expanding from systole to diastole by the same force of the thorax.—D, Pulmonary artery.—E, aorta,—and F, vena cava, kept of the normal calibre by the same force.—G G* G**, Right and left lungs expanding transversely from their state of collapse to that of extreme inspiration and in the degree of their expansion in that direction, effecting by traction from the cardiac septum, the heart's diastole.—G*** G****, Stages of downward expansion of the lungs, caused by action of the diaphragm; and effecting the heart's diastole in this direction, synchronously with the transverse thoracic traction.—H, h, Diaphragm occupying various levels according to the degree of its action.—1, 2, 3, 4, 5, Pulmonary, mediastinal and pericardial membranes, cleaving together on pneumatic principle, and thereby bringing the heart under the influence of thoracic inspiratory traction, through the medium of the expanding lungs. —H H*, H H*, Lines of oblique downward pressure, exerted by the concave contracting diaphragm on the abdominal viscera; and crossing at the umbilicus from opposite sides of the diaphragm, to the opposite groins.—I, Liver; i, gall-bladder.—J, Stomach; J*, its œsophageal end.—K K, Stages of abdominal expansile relaxation, obeying G*** G****, the contractile descent of the diaphragm.—L L, Transverse colon.—L*, Ascending colon. —M M M, Small intestines.—N N, Distended urinary bladder under pressure of the diaphragm and abdominal muscles.—N*, N*, empty and collapsed, behind the pubes, by pressure of those muscles on the abdominal contents.—O, Symphysis pubis, between which and J, the middle of the diaphragm, is drawn the line of direct downward pressure, caused by that muscle while the abdominal parietes are also in action.—(For further explanation see Commentary XIV.)

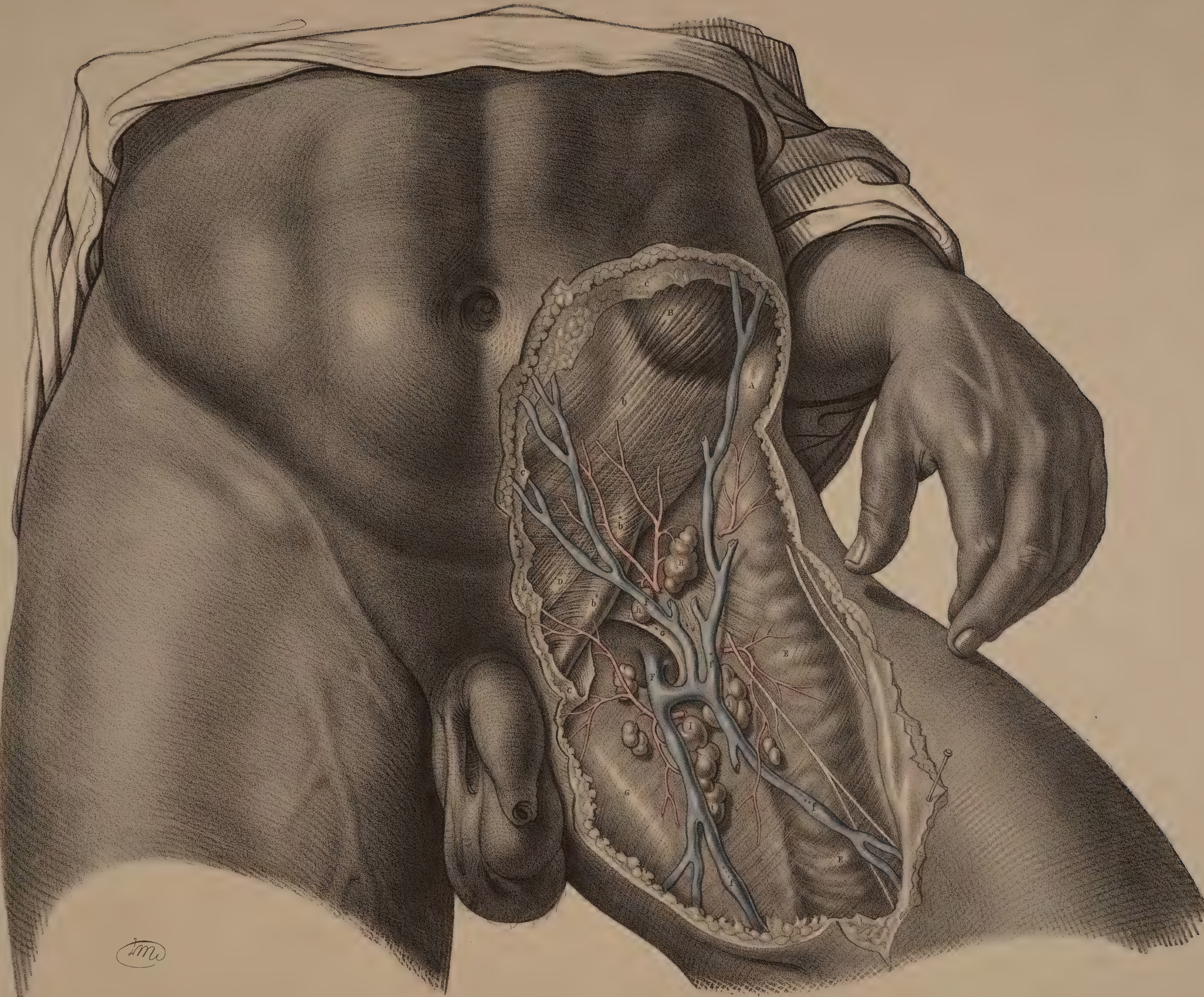
from the thorax by an upward force exerted on the passive diaphragm. To this mutuality of the action of both compartments we find that their respective organs contribute. While the organs of respiration and circulation can alone perform their functions in a thorax, their presence there is necessary to the due performance of those of the abdominal organs, and *vice versâ*. The lungs require an abdominal apparatus and its contents for their expiration, as much as they require a thoracic apparatus for their inspiration; and for all the expulsive efforts in respect to the abdominal organs, the combined action of a thorax and an abdomen is equally necessary. But the accommodatory action which, for the purpose of respiration is mutual between the thorax and abdomen in all states of their capacities, devolves principally upon the abdomen when an increase of space is demanded by its digestive and its other receiving viscera. The thoracic organs encased by the resistent ribs can dilate and contract to no greater degree than the thoracic parietes allow; and the air which the lungs inspire during thoracic expansion is in turn expired during thoracic contraction. But the ingesta of the alimentary canal requiring a longer period for their conversion to the wants of the economy, and the additional space which they occupy being required for that time, we see the necessity for the abdominal parietes being constructed of muscular material, which, while it can relax sufficiently for the gain of such space, is still active as ever for the command over the viscera. Pregnancy, a normal state, and ascites, a pathological one, are well-marked examples of to what extent the abdomen can yield, so as not to interfere with thoracic motion or the functions of the lungs and heart.

Now if (while acknowledging, according to the evidence of their anatomical condition, that inspiration is the sole act of which the thorax is capable, and that its expiration is altogether due to the action of the abdomen,) we turn to inquire what are the motions of certain of the viscera which are possibly due to the action of their containing chambers, we shall the better be enabled to discriminate those motions from those which are originated by the viscera themselves. An organ which, like the lung, is not muscular, and which, nevertheless, is distinctly and eminently expansile and collapsable, cannot be motionary, *per se*, and hence its motion must be due to the parietes of its containing chamber, to which (as noticed in a former place) it is connected on pneumatic principle. That the thoracic wall is the motor agent of the inert lung is not doubted by any: if it admitted of a doubt, the entire truth of the proposition is provable in cases of thoracic injury. But an organ which, like the heart, is unmistakably muscular, must have an action of its own, independent of other agency. Being muscular, I maintain that the heart cannot manifest of itself but *one* action, viz., contraction-systole. Being muscular, the heart, after its systole, is passive. During its passive state the heart is in diastole, exhibiting the motion of dilatation. This motion cannot be owing to any power in the heart itself to effect it, and therefore it must be ascribed to other agency. Because then the heart's *active* dilatation seems to me no less a contradiction of terms than would its *passive* contraction, because the latter term is nonsense, when applied to designate the heart's systole, and the former term is no less inapplicable to the heart's diastole, I have (Commentary XIV.) assigned the dilative force, operating for the heart's diastole, to the thoracic parietes. That these are the agents of the heart's diastole I see no more reason to doubt than that they are the cause of the expansion of the lungs; for the cause which is potential for the effect in the latter case may be so for that in the former, and therefore is, so long as it is impossible for the heart to be active for that motion. In the relative position of the heart let us look for the final cause, for, if such cause be not discernible in such position, there is no reason why the heart would not as well perform its function in the place where the stomach is. The thorax is double, and both its sides act from the centre against each other. In each thoracic compartment, a lung, enveloped doubly by a pleura, is posited. Between the two lungs is placed the heart, enveloped doubly by a membrane similar to a pleura. Upon the diaphragm rest the heart and lungs, and both organs alike obey the action of that muscle. The thoracic sides act against each other from the common centre, and the expansion of the lungs is the effect. The heart, a hollow, dilatable organ, occupies that centre, and why should it not obey the same expansile influence through the medium of the lungs? The diaphragm acts from the thorax to the abdomen synchronously with the action of the thoracic sides, and why should not the expansile effect produced by that muscle on the lungs be also exerted on the flaccid hollow heart so as to threaten vacuum in it, and move the venous blood to occupy that vacuum?

Now (without having recourse to mutilating experiment, which, by crippling nature, too often leads to lame inferences) it would appear that with the same ease that we may, by reasoning upon the anatomical condition of the thoracic organs, determine truthfully what is the source of their motions, so also in respect to those of the abdomen. In the thorax we see all the space occupied by hollow permeable organs, which as such must obey the action of the parietes. In the abdomen we find solid, inert, non-muscular organs, viz., the liver, spleen, and kidneys, &c., placed in apposition with others of hollow form, viz., the stomach, intestines, bladder, rectum, and uterus, which have muscular tissue as an element of their composition, and hence must manifest an independent motion. The solid organs may be regarded under present notice as entities, having no motions but those of the parietes with which they are in contact, and serving only to bring the hollow organs into relation with those parietes, and under their indirect influence; and, if from no other circumstance than the fact of their being under this influence, we were to infer that their own inherent actions were not adequate to the required functions in which they play their respective parts, such conclusion might be drawn with apparent reason. But the contractile power of any muscular organ, whether voluntary or involuntary, is always indicated by the quantity of muscular tissue which it possesses. The heart's systole is powerful in the degree of its muscularity, the same as the action of a pectoral or gastrocnemius muscle is great from the like circumstance. Accordingly, when we examine the hollow abdominal organs and find them composed of so small a quantity of muscular tissue, at the same time that we bear in mind the powerful efforts which are necessary to be made for the expulsion of their contents, it cannot be supposed that the action of other agents than themselves are not necessary to their function. But who that has ever considered this subject with the body of living nature in the act before his senses, can for a moment maintain the contrary opinion?

The muscles of the thoracico-abdominal apparatus have an *involuntary* and a *voluntary* action, while the action of each of its muscular viscera is altogether *involuntary*. The respiratory motion requires the alternating action of the muscles of the thorax and those of the abdomen; and all other motions of the trunk which have reference to those of the viscera are performed by those muscles, and consequently resemble, in some mode or other, the respiratory movement. Whatever be the kind of motion excited, if such motion occur involuntarily, we find we can imitate it voluntarily, and, in both instances, it is the very same system of muscles which act. While, therefore, the effect is the same, whether the causative action be at will or otherwise; while we know that, in either case, it is the muscular parietes of the apparatus which do act, and while, moreover, we are aware that the viscera are out of the control of the will, it would seem a reasonable presumption that the viscera are little else than as the inert subjects to that active force which originates in the parietes to effect such results as those of the sudden voiding of the visceral contents. In support of this conclusion we shall find parietal mechanism to answer in all respects, while the contained viscera hold their normal relative position. The diaphragm is of that form, and holds that situation which enable it during action to operate on the viscera of the thorax and abdomen at the same time. By reason of its transverse position between the false ribs, and its low lumbar origin, it can antagonise the thoracic and abdominal muscles. The effect of its action is to flatten the arched form which it has when relaxed, and in the measure of this tension, and of the corresponding relaxation of the abdominal parietes, the thoracic space becomes enlarged without affecting the abdominal viscera. But when, with the action of the diaphragm that of the abdominal muscles also occurs, the lines of force originated by the one are opposed by those of the other, and the result is a general compression of the abdominal viscera. According, then, to the direction of any one line of compression, according to the viscus to which that line is incident, and also according to the state of that viscus, does this undergo forcible compression likewise and eject its contents. The viscera are so compacted in the relative position which they have, that they must transmit the line of force to whichever one is the subject of it, and, especially, if they and it be in a state of distension. The stomach, situated between the diaphragm and the epigastrium, and the intervals between the three parts being occupied by other organs, must, therefore, suffer compression from the simultaneous spasm of the muscular parietes: and if the organ be in an atonic condition with its cardiac orifice open, and the predisposition serving, then it will void its contents. It is by the same mechanism of the parietes, and their capability of altering the lines of force in various directions, that the expulsion of the contents of any other of the abdominal organs (the urinary bladder, the rectum, and the pregnant uterus) is to be explained. In each of those several acts the body instinctively assumes an attitude which best suits for giving effect to the line of force in respect to the organ which at the time is in necessity.

PL.XXVI.



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COMMENTARY ON PLATES XXVI. XXVII. & XXVIII.

THE SURGICAL DISSECTION OF THE SUPERFICIAL AND DEEP STRUCTURES OF THE INGUINO-FEMORAL REGION.

Hernial protrusions are very liable to occur at the groin, and this it is which has led the surgeon to study with more than ordinary care and patience the anatomical relations of the structures forming this part. So minutely has he dissected every structure proper to this locality, and so closely has he investigated every possible condition of it as being the seat of hernia, that the only novelty which now remains to be sought for is that of a simplification of the facts already known to be much obscured by an unwieldy nomenclature and an useless detail of trifling evidence. And it would seem that nothing can more directly tend to this simplification than that of viewing the inguinal and femoral regions, not separately, but as a relationary whole; for as both regions are blended together by structures which are common to both, so do the herniæ, which are described as being proper to either region, occur in such close connexion as at times to render it very difficult to distinguish between them. Their operative treatment cannot be safely undertaken unless the diagnosis be correct.

The human species is, of all others, the most subject to hernia in the groin. The erect attitude of the human form and the fact that most of its more powerful muscular efforts are performed in this posture, cause its more frequent liability to the accidents in question. The viscera of the abdomen occupy this compartment completely; and, indeed, they naturally at all times subject its parietes to a state of tension, caused by their pressure, as may be observed by their escape from the abdomen in cases of wounds of this region. In the erect posture the visceral pressure is constant, owing to gravitation of the organs; and this force is at times much increased by muscular action. On making strong muscular efforts with the whole body, the thorax inspires, the diaphragm acting becomes tense and unbent from its arched form, and the abdominal muscles at the same time acting are rendered firm and unyielding; abdominal space is thereby contracted, and it is at this crisis that the viscera, reacting by their own elasticity against the parietes make an exit for themselves through those parts which are weakest—namely, the inguinal regions, towards which, being the most depending parts, the intestines naturally gravitate. But as by visceral compression on all sides is implied a tendency to visceral reaction towards all points, so we find herniæ occurring in various other situations. The contents of a hernial protrusion through the abdominal parietes correspond in general with those divisions of the intestinal canal which naturally lie adjacent to the part where the rupture has occurred. If it be at the umbilicus, it is either the transverse colon, the omentum, the small intestine, or it may be the stomach, which forms the contents of the swelling. If it be at the right inguinal region, the contents consist either of the omentum, small intestine, or the intestinum cæcum; if it be at the left groin, it will contain either the omentum, the small intestine, or the sigmoid flexure of the colon. When the rupture is in the left side of the diaphragm, the upper part of the descending colon will be found protruding into the thorax; and it is on this side that a diaphragmatic hernia can the more easily occur, for here the spleen is, if of normal size, too small to prevent it, whereas on the opposite side the diaphragm has the whole convex surface of the liver closely applied to it. It is not, however, from the special contents of a hernia that the anatomy of the parts implicated derive their chief interest, or the accident itself its particular name. Herniæ are variously named in accordance with the following circumstances: viz., the precise locality at which each occurs; the size and form of the tumour; the time of life when they happen. Sexual peculiarities do not serve radically to distinguish them, though it be true that the inguinal form occurs more commonly in the male, and the crural form in the female. The most common forms of herniæ happen at those localities where the abdominal walls are traversed by the blood-vessels on their way to the outstanding parts; and where, in consequence, the walls have become weakened. Those situations are the umbilicus—a point characterized as having given passage (in the fœtal state) to the umbilical vessels; the inguinal canal, through which the testicles passed in early life, and which is afterwards traversed by the spermatic vessels; the femoral canal, which transmits the femoral vessels; the thyroid aperture and the sacro-sciatic notch, through which respectively the thyroid and gluteal vessels pass. All points in the abdominal walls may give exit to intestinal protrusions in consequence of malformation, disease, or injury; but as the more common varieties of herniæ are those which happen at the inguino-femoral region, and these, fortunately, are the most manageable under the care of the surgical anatomist, the structures concerned in their occurrence should have first consideration.

A direct opening from within outwards does not exist in the walls of the abdomen. Anatomy renders it demonstrable that where the spermatic and femoral vessels pass from the abdomen to the external parts, they carry with them a tubular covering of the several layers of structures, both membranous and muscular, which they encounter in their passage. The inguinal and crural forms of herniæ which follow the passages made by the spermatic and femoral vessels must then necessarily have the same investments, and such others as, in addition, they encounter. If the dissection be conducted with this general idea, the several layers of structures, as they present themselves, will be the more easily and correctly understood.

The groin in its undissected state is marked by certain elevations and depressions, which may serve to indicate the relative position of the more important subcutaneous structures. The inguinal part is separated from the femoral part of the groin by an undulating groove extending from the spine of the iliac bone to the symphysis pubis. This groove or fold marks exactly the situation of that fibrous band (Poupart's ligament) which stretches between the points now named. From below the middle of this abdomino-femoral groove another will be observed directed obliquely inwards and downwards between the upper part of the thigh and pubic eminence to terminate in the scrotum; the external border of the pubic eminence which this groove bounds indicates the course of the spermatic cord to the scrotum; and the cord can be readily felt along it beneath the skin. In all subjects, however gross or emaciated they may be, these two grooves are plainly distinguishable; and as they bear relation to the several kinds of rupture taking place here, the surgeon should consider them with interest. It is Poupart's ligament and the spermatic cord which chiefly determine the shape of the inguino-femoral region. On removing the integument we find much adipose substance still preserving the outward form of the groin, owing to its being invested by a thin layer of loose membrane, which is named the superficial fascia. This membrane may be now traced from over the abdomen and the pubes to where it becomes intimately connected with Poupart's ligament; and

FIGURE OF PLATE XXVI.

A, Anterior spinous process of ilium.—B, External oblique muscle; b, Its aponeurosis; b* b*, Its production over the cord as the external spermatic fascia.—C C, Superficial fascia.—D, Insertion of aponeurosis into the crista pubis.—E E, Sartorius muscle covered by fascia, and crossed by cutaneous nerves.—F, f f*, f**, Saphena vein and its anterior, femoral, epigastric, and external iliac branches.—G, Fascia lata.—G*, Falciform process of saphenous opening.—H h, Inguinal lymphatic bodies.—I i, Femoral lymphatic bodies.

after forming a loose covering for the cord, descends with it to the scrotum. It is the same fascia which from the line of the ilio-pubic groove ensheaths the upper part of the thigh subcutaneously, and here masks the features of the fascia lata. At its connexion with Poupart's ligament the superficial fascia is devoid of adipose substance, and binds the thin integument to the ligament; but above this structure over the abdomen and pubes, and below it over the thigh, the meshes of the membrane being loaded with fat will account for the permanency of the fold of the groin after the integument is dissected. The other parts in which the character of the membrane varies are the scrotum, where no fatty substance exists in it; and the adjacent part of the thigh, where, owing to its being perforated by numerous small arteries, veins, and lymphatics, it is named the "cribriform fascia." As the membrane thus invests all parts of the groin, so will it always be found forming the subcutaneous covering of the hernia, whether this be inguinal or femoral. And as it is attached along the ilio-pubic line to Poupart's ligament, thus separating the abdominal parietes, the pubes, spermatic cord, penis, and scrotum from the thigh, so when urine happens to be extravasated into this abdomino-scrotal bag of the membrane, the effect of that accident does not involve the thigh. The general relations of the superficial fascia are described by Camper thus: "Musculus obliquus igitur externus abdominis, qua parte carneus est, membrana quadam propria, quali omnes musculi, tegitur, quæ sensim in aponeurosin mutata, ac cum tendineis hujus musculi partibus unita, externe ac anteriore parte abdomen tegit; finem vero nullibi habere perspicuum est, ad pubem enim miscet cellulosa membrana, cum ligamento penis in viris ac clitoridis in feminis, involucrum dat musculo cremasteri, ac aponeuroseos speciem musculis anterioribus femoris, qua glandulæ inguinales, ac cruris vasa majora obteguntur." (*Icones Herniarum.*)

Having now examined the superficial fascia, and the manner in which it moulds the adipose substance to the characteristic shape of the region under notice, it becomes necessary to remove them, in order fully to expose the parts but as yet partially visible. This being done, we have in view the aponeurosis of the external oblique muscle of the abdomen and the fascia lata of the thigh both joined along the ilio-pubic groove, where they form Poupart's ligament, and still maintain the shape of the groin. This region may, with a view to the clearer explanation of the surgical anatomy of it, be conveniently described as presenting two triangular spaces, the one inguinal, the other femoral, placed base to base. The inguinal triangle may be defined by a horizontal line, drawn from the iliac spine to the umbilicus, and by a perpendicular one from this point to the symphysis pubis: the femoral triangle is represented by the sartorius muscle arising from the iliac spinous process, and the adductor longus from the symphysis pubis, and both meeting at the upper third of the thigh, while Poupart's ligament represents the conjoined bases of the two spaces. In the intervals thus marked out, we have the parts respectively concerned in the two forms of hernia here occurring; in the upper space appears the spermatic cord, emerging from the abdomen, close above the inner third of Poupart's ligament, whilst close below the same portion of that structure, appears the saphenous opening in the fascia lata. Both spaces will now be noticed to be traversed by the superficial bloodvessels and nerves. Ascending from the inner side of the thigh, the saphena vein, the largest of those now apparent, gains the saphenous opening, which it enters to join the femoral vein concealed beneath the fascia. Previously to entering the opening, the saphena vein is joined by others congregating from the iliac and hypogastric regions, and also from the outer, inner, and foreparts of the thigh, so as in this place to form a plexus, the branches of which are visible beneath the skin during life, and hence may be avoided in surgical operations. In company with each of those veins is a small branch of the femoral artery, all of which as they course in the direction of larger deep-seated branches of that vessel, are named accordingly, viz., superficial epigastric, circumflex iliac, and pudic. Those small arteries pierce the fascia lata, immediately below Poupart's ligament; one or more of them are always divided in operations for herniæ, but their small size renders this of little consequence. The branches of nerves which appear with those vessels, are also of small size: the principal of them are the external cutaneous, derived from the lumbar plexus, and appearing on the fascia, a little below the iliac spine; and the middle and internal cutaneous, given off from the anterior crural nerve. The groin is remarkable, like the axilla, for containing a large number of lymphatic bodies, which can be felt beneath the skin. They form two principal groups, one of which overlies the middle of Poupart's ligament, and the other close to the saphenous opening, among the plexus of veins. Those of the former group receive the lymphatics of the generative organs, and are liable to inflame when those parts ulcerate; those of the latter group sympathise with irritations of the leg and thigh. Such of the veins and lymphatic bodies as obscure the parts on which they lie, may now be removed.

The aponeurosis of the external oblique muscle and the adjacent part of the fascia lata being now in view, we find the inguino-femoral groove to be permanent in all positions of the body, while the forms of the regions above and below it vary according to those positions. That of the inguinal region varies more than that of the femoral, owing to the mobility of the viscera: the anterior bulge which the viscera give to the inguinal wall, even in the recumbent posture, is much more prominent when the body is erect; and as this circumstance shows that the inguinal wall is not only retentive, but supportive of the viscera, so the dissection will gain an interest, if conducted with a view to explain the natural provision made for both offices, and in what respects it fails of those ends.

The inguinal region is sheathed throughout by the aponeurosis of the external oblique. The fleshy fibres of this muscle embrace the loins between the false ribs and the crest of the iliac bone, and appear no farther in front of the abdomen, than about the place of the spinous process of the ilium. At this part the broad tendon of the muscle commences, and passes in parallel fibres, obliquely, downwards and forwards, to the linea semilunaris, with which it is connected, and thence to the linea alba, the symphysis and crest of the os pubis. When we examine the structure of the aponeurosis more closely, we find it to vary in several parts, both as to the arrangement and the thickness of its fibres; according to the characters of those parts, though they are inseparable from the entire structure, different names are assigned to them. Between the iliac spine and the crista pubis, we observe the lower part of the aponeurosis to consist of a strong band of fibres, which is the medium of union between it and the fascia lata. This is Poupart's ligament, which represents the line of demarcation between the groin and the thigh, and by its strength serves specially to support the former part from the latter, in the erect posture of the body. Its office as a ligament is hence much less obvious than its office as a support against superincumbent visceral pressure; and accordingly we notice it to be stretched between the iliac spine and crista pubis, not tensely in a right line, like the chord of an arc, but lax and curving towards the thigh, like the arc of a circle, and in the degree of the pressure on it. Immediately above the middle of Poupart's ligament, may be observed the commencement of a separation between the fibres of the aponeurosis for the transmission of the spermatic cord. The fibres so separated form two other bands, which, gradually widening from each other as they proceed inwards, become inserted, the upper one into the symphysis pubis, and the lower one into the spine and pectineal ridge of that bone. Those bands are the "pillars" of the external abdominal ring. The interval between them is the "external ring;" but it is in fact more generally of a triangular form, having its apex above the middle of Poupart's ligament, and its base between the spine and symphysis of the pubes into which its pillars are respectively inserted. The external ring, which, viewed as the interval between its diverging pillars, exhibits an angular shape, assumes a circular one by reason of other fibres which cross the pillars at varying angles. The fibres, disposed crossways, constitute the "intercolumnar fascia," which, however, is as much identified with the aponeurosis of the external oblique muscle as are the pillars or Poupart's ligament. From this peculiar arrangement of the two sets of fibres of the aponeurosis it is evident that the immediate object is to give strength to the lower part of the groin, where it is habitually most required, and to this end they cross each other like woof and warp of woven texture.

Where the spermatic cord, emerging from the abdomen, becomes definable through the fibres of the inguinal aponeurosis, viz., at a point about midway between the iliac spine and pubic symphysis, and in the direct line between those two points, we find it distinctly sheathed by a production of that structure. It is of those fibres of the aponeurosis which constitute the intercolumnar fascia that the cord derives its envelope, and this is named the "external spermatic fascia." In the same direction that the intercolumnar fascia rounds the pillars of the external abdominal ring, we see them crossing and incasing the cord as low down as where it enters the scrotum, and where it becomes so filmy and transparent as to be scarcely discernible from the cellular membrane, though, in many cases, it exists as a distinct tubular covering for the cord as low as the testicle. In the female a similar envelope derived from the same part covers the round ligament; but in the early fœtal state, when the testicle has not passed from the abdomen, and also in the adult in whom an arrest in the descent of the testicle has occurred, we find with the absence of the cord an occlusion of the external abdominal ring by those very fibres (intercolumnar) which

Fig 1.

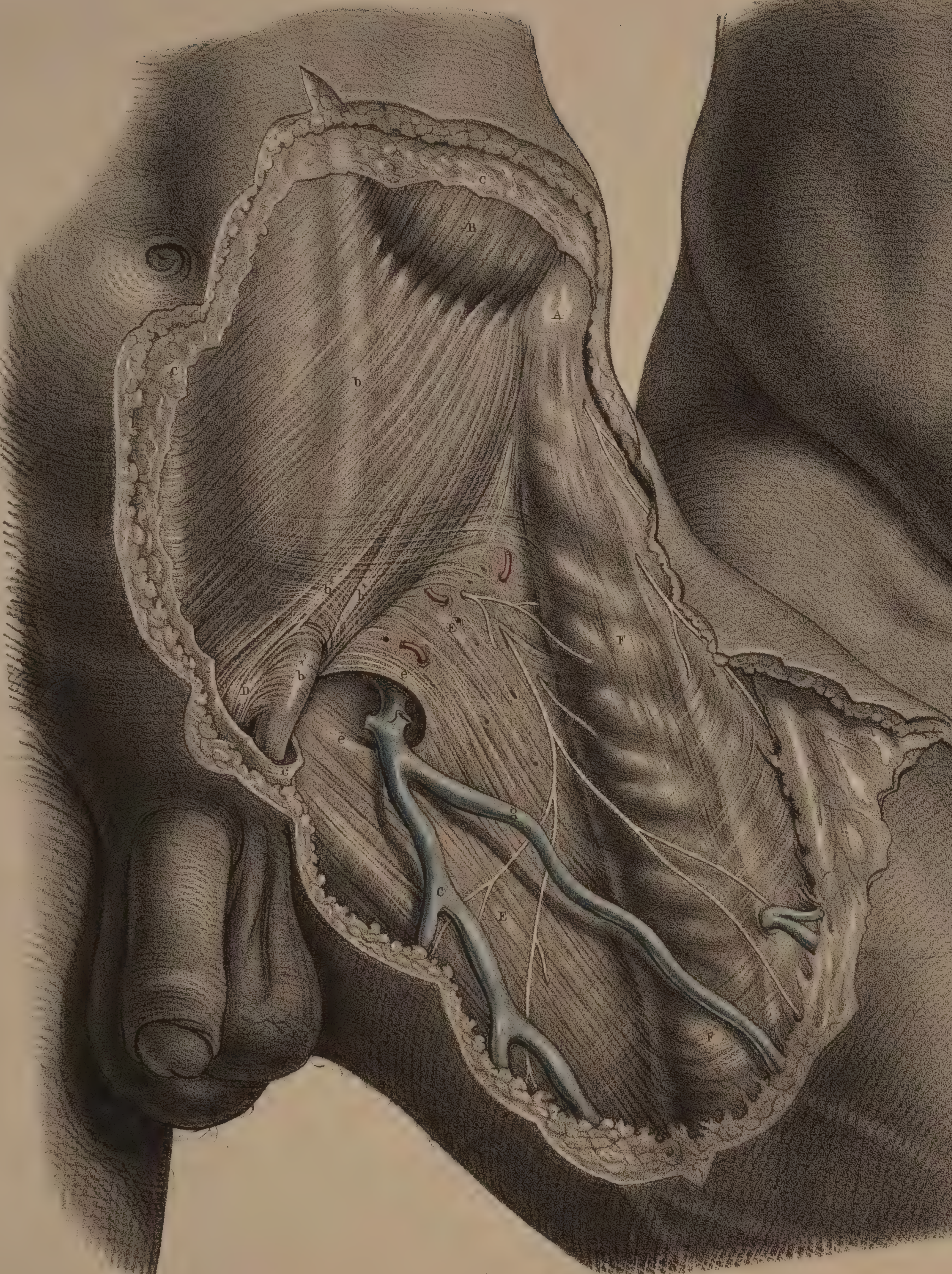
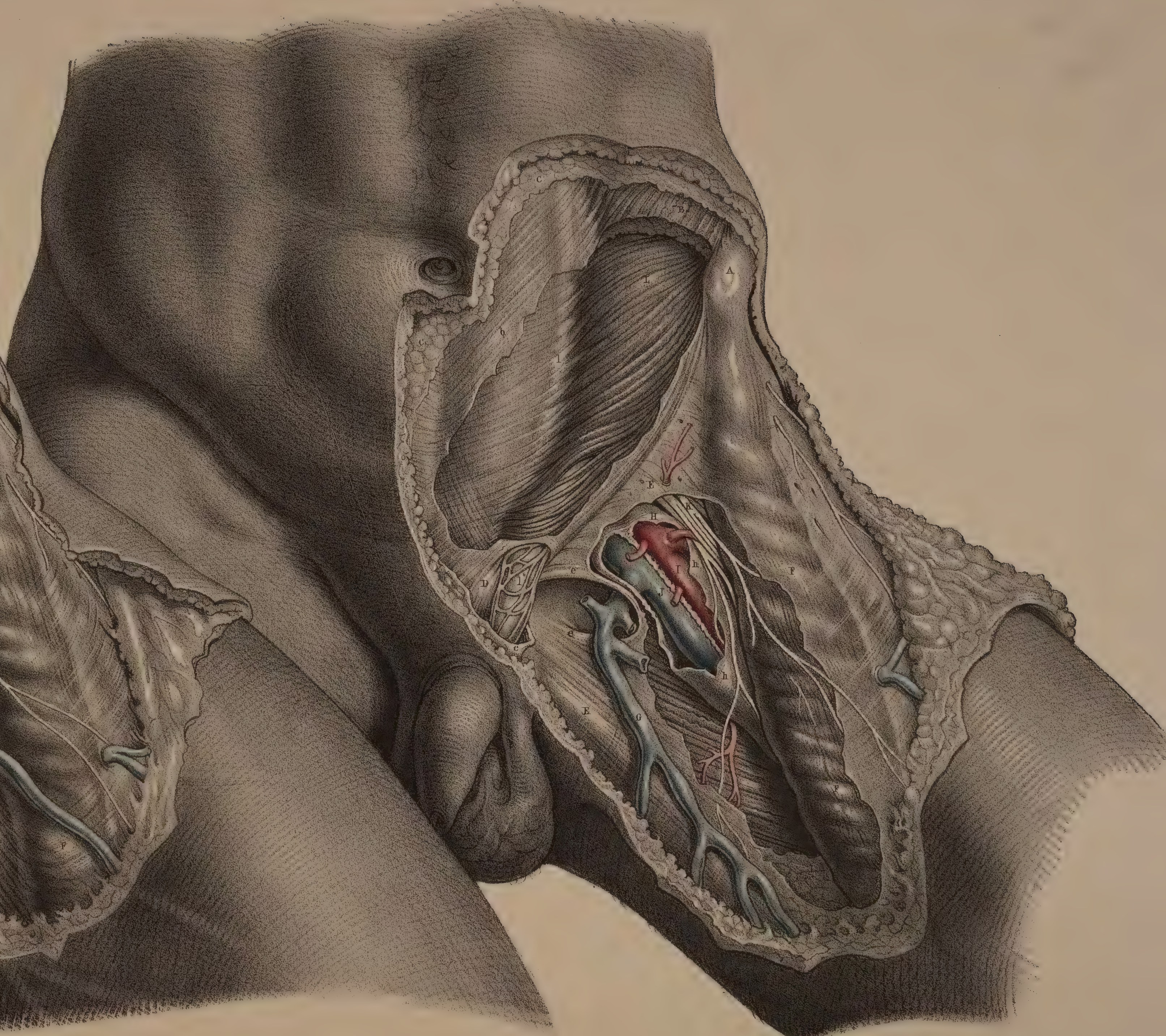


Fig 2.



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give the cord, when appearing outside the groin, a covering. From those facts it will be evident that the so-called external ring does not exist as an *aperture* with defined margins formed in the tendon of the external oblique muscle. Such a state does not exist till, in dissection, we make it. It is only when we divide the spermatic fascia from the intercolumnar that we form the ring, and then, of course, it must be regarded as artificial. In the same manner, then, as the cord takes a covering from the superficial fascia, does it take another from the internal columnar part of the aponeurosis of the external oblique muscle, and when the hernia descends through the cord, both those membranes must likewise invest the intestine. Although this point, where the spermatic fascia is derived from the aponeurosis, varies in several individuals, yet the fact of the external ring being the mouth of a tube never varies. But upon the form and situation of the origin of the cord depends, in great measure, the strength or weakness of the groin. In some instances the cord becomes pendulous much farther outwards than is usual, and consequently at a point so nearly opposite to the internal ring as to offer a direct passage to hernial protrusion. In other instances the pillars of the external ring are bound together by the intercolumnar fibres so far inwards as to support and cover the cord till it touches the spine of the pubes, and by the oblique direction thus given to it in its passage through the inguinal parietes it is fortified against hernia. The latter condition is the more usual, and in all such cases the cord, where first observed, drops over the lower band or pillar where this is about to become attached to the crista pubis, while the upper band is unconcealed by it. When a hernia protrudes through the external ring, it has the same relation to the pillars as the cord has; but the position of the spermatic vessels, though still enveloped by the same coverings as the hernia, is subject to vary from causes to be noticed hereafter.

On turning next to the examination of the fascia lata we find this to be so intimately connected with the lower border of Poupart's ligament that the two structures may be regarded as continuous and one. The ilio-pubic groove, which at first sight appears to separate them, does not do so in fact, for we find the groove crossed, especially at its outer two-thirds, by bands of fibrous substance derived from the fascia lata, and directed upwards and inwards through the texture of the inguinal aponeurosis, and binding the parallel fibres of that membrane together. Those bands form the intercolumnar and the spermatic fasciæ as they cross the external ring. In the femoral triangle, of which Poupart's ligament represents the base and the sartorius and adductor longus muscles the sides, the fascia lata is remarkably strong and fibrous, so much so, that the parts beneath it do not appear through it; but where it forms sheaths for the muscles it is thin and transparent. The fascia is here surgically divisible into two parts—an external or iliac part, and an internal or pubic. The occurrence of an interval between them serves to divide the parts, but below the opening they are continuous. The iliac part is of much denser structure than the pubic, and occupies a higher plane than it. It is the iliac part which is connected with Poupart's ligament along its whole extent from the crista pubis to the iliac spinous process, and beneath which the femoral vessels pass. When we trace this portion of the fascia from the crista pubis over the upper and inner part of the thigh, we find it presenting an apparently abrupt edge of crescentic shape (the falciform process) looking towards the pubes, and receiving beneath it the saphena vein and its tributaries; but the edge of that process, as now defined, has required a dissection which must teach that it does not naturally exist of this form, for we have had to separate from it the superficial fascia with which it is in the natural state of the parts blended, and also some adipose-cellular membrane which occupies the cleft between it and the pubic part of the fascia. The pubic part of the fascia closely invests the adductor muscles at their origins, and is so thin that these can be partially defined through it. As those muscles incline backwards from their pubic origins to their insertions into the thigh-bone, so the fascia which follows them must pass beneath the iliac fascia and behind the femoral vessels which are supported on those muscles. From this disposition of the two portions of the fascia to which dissection has given the appearance of being separated above, and which are actually joined below, we find as the result of a kind of folding of one part on the other, an interval formed between them for the space of about two inches below the inner third of Poupart's ligament, and this interval is named the "saphenous opening," although exhibiting none of the characters of an *aperture*, either as nature presents it or as the scalpel has made it.

The saphenous opening presents in some respects an analogy to the external abdominal ring, although the two happen in different situations and in relation to different parts. Both have reference to bloodvessels transmitted from the abdomen outwards; the forms of both are due to the manner in which those vessels pass; the herniæ which occur in them are the consequence of both being weaknesses in the inguinal parietes; and the membranous investments which those herniæ derive in their way through both are, with one or two exceptions, of the very same kind. However, notwithstanding those general features of their similitude, we find anatomical differences between them, and, obvious as those differences may appear, a comparison of them may not be without some practical interest. In regard to *size* the external abdominal ring measures in general about a fourth of the area of the saphenous opening; and as both are constructed of strong fibrous substance not easily dilatable, so may we expect that the lesser of the two will offer the greater amount of constricting resistance to the hernia which it transmits. As to *situation* it may be observed that, though the saphenous opening is femoral and the external ring, inguinal, yet the difference in this particular is chiefly apparent in respect to their distal borders. The proximal borders of the two are in such close apposition that they are traceable from the same point, viz., the crista pubis. Into this part are inserted the inferior pillar of the ring, and the superior cornu of the falciform process of the saphenous opening, the width of both measuring only a few lines. And as the cord depends immediately outside the crista pubis over the parts attached to this point of bone, and consequently over the upper part of the saphenous opening, so may the inguinal and femoral herniæ reach the same situation, and render it difficult to distinguish between them if other features be obscured. In *form* the difference between the external ring and saphenous opening is well marked. The former is tubular, by reason of the manner in which the testicle has carried down with it a process of the inguinal aponeurosis, but the latter is valvular by a folding of the fascia lata, which hence appears of two distinct parts in bounding the cleft between. The existence of the saphenous opening is determined altogether by the falciform process of the iliac part of the fascia lata; and this process does not appear of that form till we have dissected the superficial fascia from its connexion with it. To this circumstance is to be ascribed the fact that so accurate an observer as Sœmmering (*de Corporis Humani fabrica*) has taken no notice of the saphenous opening. But when we consider the falciform process as it appears from dissection, it gives existence to the saphenous interval by its own peculiar figure and relative position. From its crescentic form it is divisible into a middle part and a superior and inferior cornu. By its standing apart from the pubic fascia lata it occasions between both a shallow valvular interval, which is merely a recess separated at all points, not only from the sheath of the femoral vessels but from the abdominal interior. Now, as this recess (saphenous) could not be thus insulated if the falciform process were a single layer of membrane, but may be so if the process were a fold and consisting of two layers, we accordingly find, on passing the point of the finger beneath the process, that the latter is its real condition. On making a section of the part at any point between its two cornua we distinguish those two layers, the one being superficial to the femoral vessels and the other being behind them. The saphenous opening, therefore, is only such in outward seeming, and the cause of its occurrence is a folding of the fascia to form a protecting covering for the femoral vessels which are immediately outside it.

While the groin as yet retains its normal form from the inguinal

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FIGURES OF PLATE XXVII.

Fig. 1. A, Anterior spinous process of iliac bone.—B, External oblique muscle; b, its aponeurosis attached to the linea semilunaris; b* b*, forming pillars of the external ring; b**, forming external spermatic sheath.—C, Superficial fascia.—D, Crest of pubis.—E E, Facia lata; e e, saphenous opening.—F F, Sartorius muscle covered by fascia, and in relation with the internal and external cutaneous nerves.—G, g, Saphena vein.

Fig. 2. Corresponding parts marked as in fig 1.—H, h h, sheath of femoral vessels.—I, Femoral artery.—J, Femoral vein.—K, Anterior crural nerve.—L, Internal oblique muscle; l, is tendon attached to linea semilunaris; l*, its cremasteric fibres protruding on the cord through external ring.

aponeurosis, and the fascia lata being entire, it will be of advantage to ascertain in how far those parts are influenced by the motions of flexion and extension, for the reduction of hernia by the *taxis* is acknowledged to be either hindered or facilitated by those motions; and at the same time it may be determined which are the proper situations where a section of the parts can give, with most safety, the greatest degree of relaxation, for according to this the reduction of hernia by a cutting operation is best to be effected. The degree of tension which the groin exhibits in the erect posture is chiefly due to the superincumbent weight of the bowels, for when the body is laid supine, these gravitate towards the back, and the groin is, in consequence, rendered flaccid. But even while the body is supine, if we extend the thigh from the abdomen, both parts will be put on the stretch, and this is owing to the connexion which the fascia lata has with the inguinal aponeurosis, through the medium of Poupart's ligament; for on flexing the thigh at the same time that the body is supported forwards all three structures become equally relaxed. Viewing the effect of those postures on the external abdominal ring, we find that it is but little changed either as to form, size, or situation; but evidently the flexion of the thigh partially relaxes it, while the extension of the thigh renders it somewhat more tense than usual. The saphenous opening is, on the contrary, much changed during these motions. On extending the limb, the vertical diameter of the opening is elongated; its depth (seldom more than a few lines) is decreased, and both these conditions are due to the tension of the falciform process. When the limb is flexed changes are effected in the saphenous opening of an opposite character, and chiefly owing to the relaxation of the falciform process. In considering the reason why the external ring is less influenced than the saphenous opening by those motions, it appears to be owing to their respective place and the connexions of their formative parts: the pillars of the ring are inserted into two fixed points of the pubic bone, and the ring itself is so near that bone that the position of the thigh cannot exercise any very marked change in it; but the falciform process being connected by only one part—its upper cornu—with the os pubis, may admit, on that account, of all the changes now noticed. The practical application of these facts is obvious: for the reduction of all varieties of hernia in the groin the body should be laid supine, and the thigh should be flexed; but it appears that the advantages of this position are more positive in respect to the femoral than to the inguinal hernia. With regard to the most eligible line of section for obviating constriction this might be easily determined, but that the safety of the bloodvessels has at the same time to be considered. For widening the external abdominal ring a section of the aponeurosis in any direction radiating from that point over the inguinal and hypogastric regions would effect that object sufficiently, so that the section (towards the umbilicus) which, with a view to avoid the epigastric artery, we ought to make, will, for the liberation of the constricted part, answer as well as any other. The same remarks apply to the saphenous opening when the object is to widen it in cases of constriction. Any line of section made from the centre of this opening through an arc reaching from the iliac spine to the symphysis pubis, provided it divide the falciform process and Poupart's ligament, will relieve constriction; and, therefore, the section of the parts in the direction of the crista pubis, which for avoiding the femoral vessels should be always chosen, will be found as effectual as one in any of the other directions. The truth of this will appear when the vessels are in view.

In proceeding to expose the next layer of structures it is required to dissect off the aponeurosis of the external oblique muscle, together with the fascia lata. If the dissection be so conducted as to leave Poupart's ligament entire, and also the borders of the parts forming the external ring and the saphenous opening, the relation of the structures will be the more clearly seen. This being done, we have now in view the inguinal part of the internal oblique muscle above Poupart's ligament and the sheath of the femoral vessels below it. The internal oblique muscle, compared with the external, is of a very different shape, both as to its fleshy and tendinous parts; the aponeurosis of the latter covers the fleshy fibres of the former. The fleshy part of the internal oblique arising from the crista ilii and outer two-thirds of Poupart's ligament passes over the inguinal region as far inwards as the linea semilunaris with which it is connected even as low down as the external ring. At the linea semilunaris the tendon of this muscle first appears, and thence stretches inwards to the linea alba, beneath the aponeurosis of the external oblique, covering the rectus muscle. On examining the lower border of the muscle—that in connexion with Poupart's ligament, it seems to be but ill defined in this situation; and while tracing its fibres here from origin to insertion I find them mingling imperceptibly with a set of looping fibres which protrude with the cord through the external ring and accompany it as an investment into the scrotum. It is in this condition of the muscular fibres that the descriptive anatomist sees a reason to distinguish between an internal oblique muscle and a cremaster; but while continuity of similar parts establish a whole, he, in fact, cannot correctly in any case regard the two as distinct muscles. If this distinction is difficult to be drawn in a wasted state of the muscular parts, it is altogether impossible to define it in the state of full muscular development. When, in a subject presenting the latter condition, we examine the lower portion of the internal oblique, it will be found sheathing the whole inguinal space from side to side; and on tracing the extent of its origin from Poupart's ligament, we find its fibres attached to that structure as far inwards as the external ring, having the same oblique arrangement downwards and forwards. In this serial order as to origin the fibres of the external oblique are continued by the fibres of the cremaster, and when those of the latter have passed the external ring, they then first assume the form of inverted loops upon the cord, exhibiting the character of descent and ascent, and plainly expressing that the testicle, in its passage to the scrotum, has given them this form; for not only do the descending cremasteric fibres arise from Poupart's ligament like the fibres of the internal oblique, but the ascending cremasteric fibres are inserted into the lower end of the linea semilunaris in serial order also with the fibres of that muscle. Such, then, being the actual state of the parts, expressing by every feature that the testicle and cord have derived their cremasteric covering at the expense of the internal oblique muscle, we may conclude that no distinction can be made between them because they are parts of the same whole form now as they originally were. In the same manner, therefore, as the fascia spermatica is a tubular production of the aponeurosis of the external oblique, so is the cremaster of the internal oblique. If Cloquet (*Recherches Anatomiques sur les Hernies de l'Abdomen*) had never demonstrated the correctness of this view, another would have. That such was my own view of the parts ere I consulted that work will appear in future remarks.

By making a vertical incision through the internal oblique, midway in the inguinal region, and turning aside the dissected parts of that muscle, we expose the transversalis muscle of similar shape and dimensions to the one now divided. The connexions of both muscles are also alike, inasmuch as they arise from the crest of the iliac bone and the outer two-thirds of Poupart's ligament, and are inserted into the whole length of the linea semilunaris. Their muscular fibres in this situation have much the same direction—viz., downwards and forwards towards the lower part of the rectus. In the inguinal region the three abdominal muscles form successive strata; but their tendons, in forming the sheath of the rectus muscle present a peculiar arrangement. While the three tendons appear to be incorporated along the border of the rectus, and in this manner to form the linea semilunaris, anatomists describe them as encasing the rectus muscle thus:—the tendon of the external oblique passes altogether in front of the rectus; that of the internal oblique splits at the border of the rectus into two layers, which enclose that muscle between them, but midway between the navel and pubes both layers pass in front of the muscle; the tendon of the transversalis passes behind the upper three-fourths of the rectus, but at the lower fourth it joins both layers of the internal oblique, and with them passes in front of the rectus. From this disposition of the tendons, whether true or otherwise, we find the pubic part of the rectus muscle devoid of the sheath behind, and lined in this place by the abdominal membranes. Corresponding with the part where the tendons unite and pass in front of the rectus we find them forming on the outer border of that muscle, and continuing the linea semilunaris downward, a dense fibrous band which the surgical anatomist has named the "conjoined tendon." By this part the abdominal muscles become inserted into the pectineal ridge of the pubic bone; and as it appears immediately behind the external ring it serves to fortify this opening against direct intestinal protrusion. The conjoined tendon is in some individuals of less breadth and density than in others, and to this circumstance may be ascribed the greater liability of the former to the accident named.

On examining the lower border of the transversalis muscle, I find it, especially in muscular subjects, to present features similar to those already mentioned of the external oblique. The two muscles here blend together, and in the serial arrangement of their fibres and those of the cremaster there is no natural separation, thus at once suggesting the idea that the cremaster is a derivation from them both. Assuming this to be the case, it must therefore follow that when the dissector removes the cremasteric fibres from above Poupart's ligament, and gives unnatural definition to the lower borders of the transverse and oblique muscle, he himself causes that vacancy in the muscular parietes of the groin which

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Fig 1.

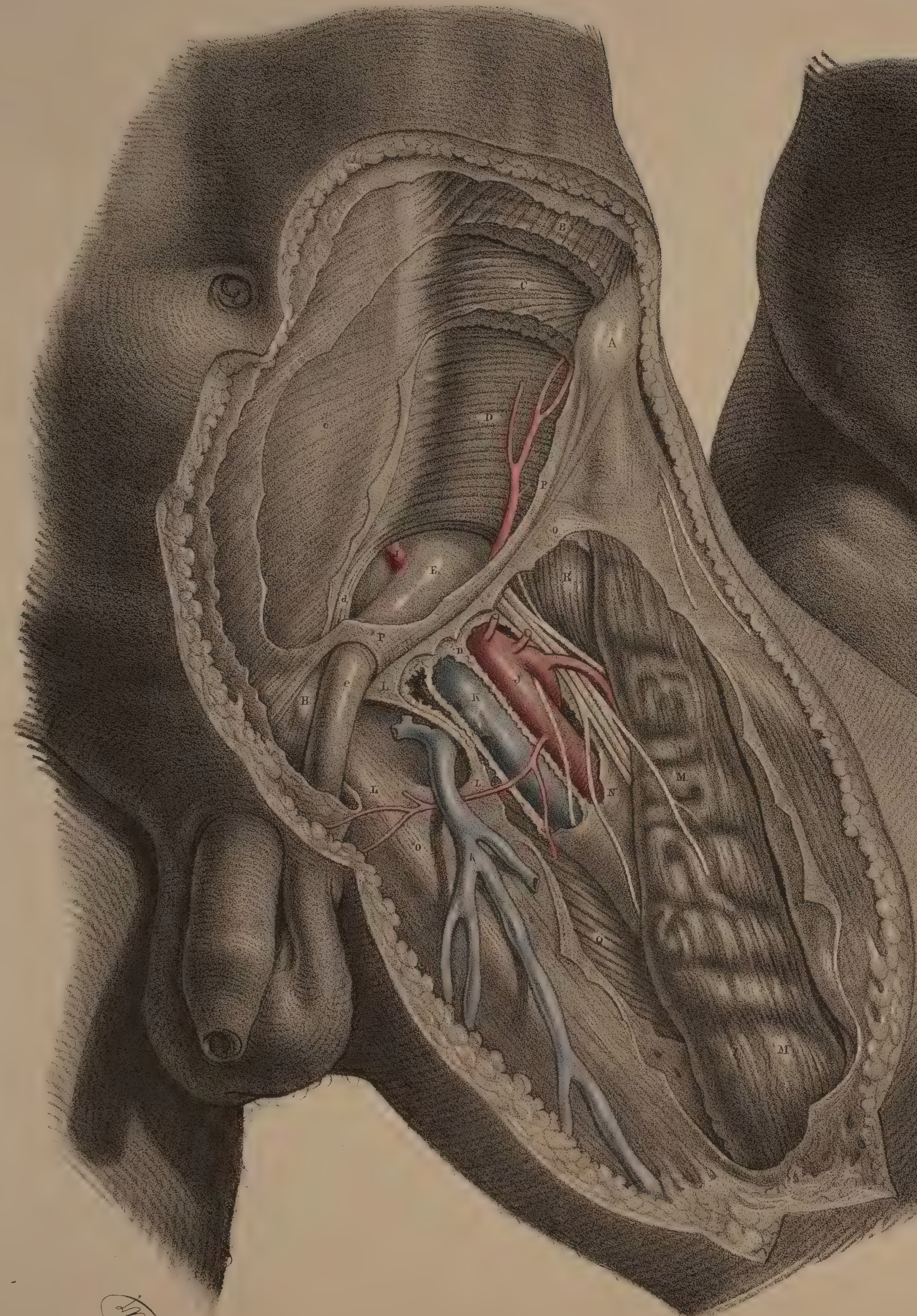
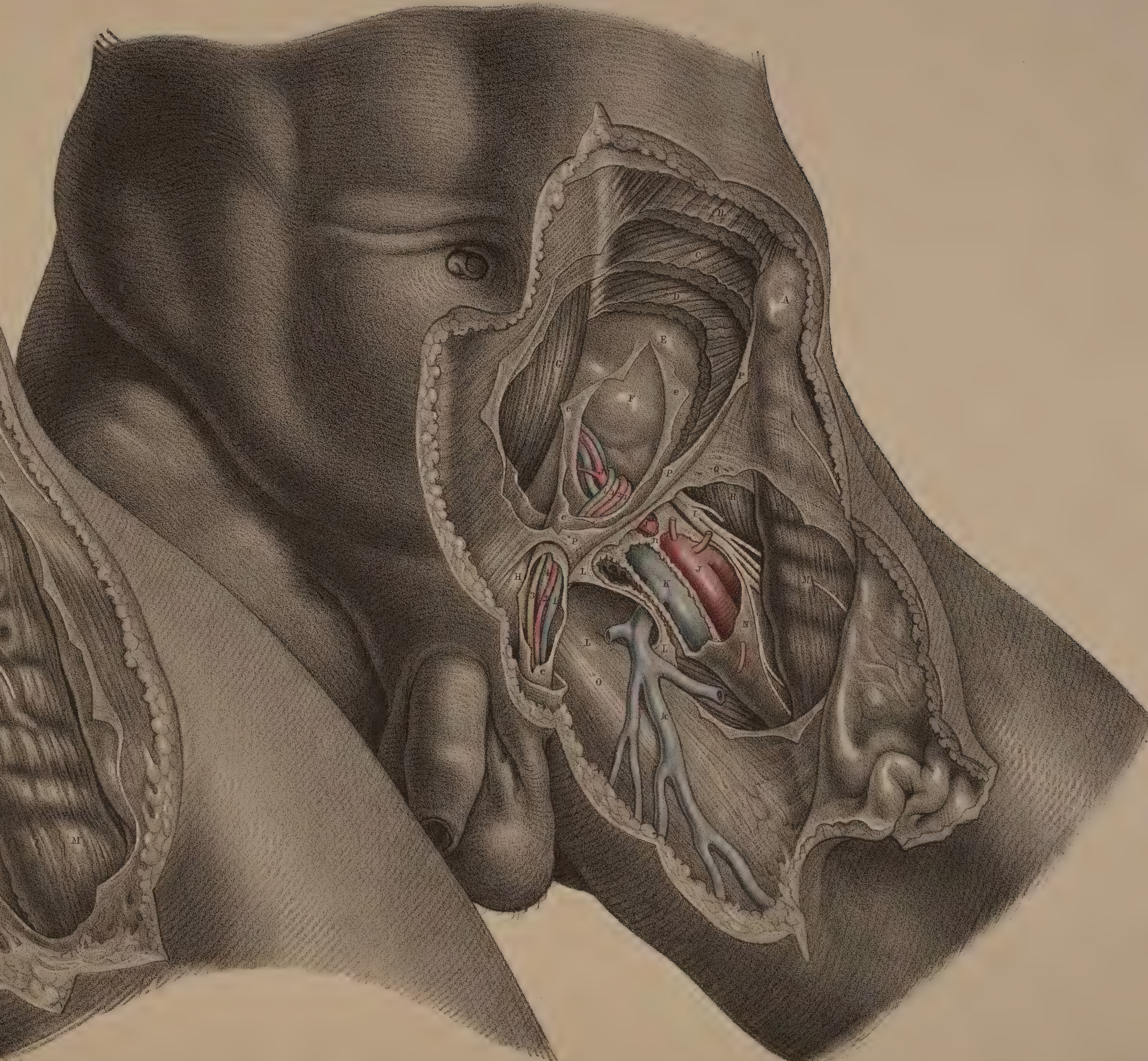


Fig 2.



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does not naturally exist in the neighbourhood of the origin of the cord. In the dissection so conducted, the cord is made to assume the variable positions which anatomists report it to have in respect to the muscles now under notice. But when we view Nature as she is, and not as fashioned by the scalpel, we never fail to find an easy explanation of her form. In the fœtus, prior to the descent of the testicle, a cremaster muscle does not appear protruded through the external ring (Cloquet, op. cit.), and in this case the space immediately above Poupart's ligament is entirely sheathed by those parts of the muscles which subsequently the passing testicle converts into a cremaster. In the adult, in whom one of the testicles has been arrested in the abdomen, I have observed that the muscles do not present a defined arched margin around the commencement of the cord, but appear (as in the fœtus) as low as Poupart's ligament. In the adult in whom the testicle has descended to the scrotum, the cremaster always accompanies it, and the cremasteric fibres are serially continuous with those of the inguinal muscles, thus covering the space above Poupart's ligament, and rendering it evident that "cremaster" is but another name for the lower parts of those muscles. Again, in the female, in whom the spermatic vessels do not appear, the inguinal muscles present in their full quantities, having sustained no diminution of their bulk by the formation of a cremaster. But when an external inguinal hernia occurs in the female, the bowel in its descent carries before it a cremasteric covering at the expense of those same muscles, just in the same way as the testicle does in the fœtus (Cloquet). Such being the facts, the following inferences may be legitimately drawn therefrom:—1st, that the inguinal space is not naturally devoid of a muscular covering, while the cremaster exists and owes its form to the manner in which the testicle has metamorphosed those muscles; 2nd, that the name cremaster is one given to the lower parts of the internal oblique and transverse muscles which cover this space and protrude through the ring; and 3rd, that to separate the cremasteric elongation of those muscles, and then describe them as presenting a defined arched margin over the origin of the cord, an inch or more above the middle of Poupart's ligament, is an act as arbitrary on the part of the dissector as if he were to subdivide those muscles still more, and while regarding those subdivisions as complete forms, to give them names of different signification. When once we consent to consider the cremaster as constituted of the fibres originally proper to those muscles, we then are led to the discovery of the true relations of the cord in this situation.

By removing the internal oblique, transverse, and cremaster muscles, we expose the inguinal part of the transversalis fascia. This membrane affords a general lining to the abdominal parietes, in some situations of which (particularly the groin) it appears of denser and more fibrous texture than in others. It is stretched over the abdomen between the muscles and the peritonæum. The fascia iliaca, pelvica, and transversalis, are only regional divisions of the one universal membrane. Viewing this membrane in its totality, I find it exhibiting many features in common with those other fibrous structures which envelope serous cavities. The transversalis fascia supports externally the peritonæum, in the same way as the dura mater supports the arachnoid membrane, or as the pleural fascia supports the serous pleura; thus, while the serous membranes form by their visceral and parietal portions completely shut sacs, reflected from the vessels as from other parts, the fibrous membranes which are external to the serous are pierced by the vessels which course between them and the serous, and afford sheaths or envelopes for those vessels in their passage from the cavities to the external structures. The sheaths of the spermatic and the crural vessels are productions of the fascia transversalis. In the groin, the membrane is in general of so dense a texture as must offer a considerable resistance to visceral pressure, which is here very constant, and in full force. The fascia is here adherent to the external surface of the peritonæum, and to the inner surface of the transverse muscle by means of intervening cellular tissue. On tracing the fascia from the hypogastric and iliac regions to the middle of the groin above Poupart's ligament, we find it forming a canal-shaped elongation, which invests the spermatic vessels, and descends with them to the testicle in the scrotum. This elongation is named the "fascia spermatica interna" (Sir Astley Cooper) and "fascia infundibuliform," (Cloquet.) The same part, when it encloses an external oblique hernia, is named "fascia propria." The neck or inlet of this canal, which is its widest part, is oval, and constitutes the internal abdominal ring, which, as it looks towards the abdomen, and forms the entrance of the canal, cannot of course be seen from before until the canal is slit open. The relative position of the internal and external rings may be now seen, and also the extent and oblique direction of the cord between them. While the internal ring is formed in the inguinal portion of the fascia transversalis, we find the hypogastric portion of this membrane fencing the external ring behind the cord, and becoming incorporated at this place with the outer border of the conjoined tendon in a line with the linea semilunaris. The space which the cord traverses between the two rings is the "inguinal canal." The length of the canal is generally from an inch and half to two inches; its varieties as to length depend upon whether the external ring is farther from the pubes than usual, or whether the internal ring approaches nearer the pubes than it ordinarily does. Under either circumstance, the position of both rings will the more nearly correspond; and in the degree of that correspondence the groin becomes the more liable to hernial protrusions. A comparison of the two rings will show that the parts in which the internal one is formed are more yielding than those of the external, and hence less likely to strangulate a hernia.

In very much the same form as the spermatic vessels derive their envelope from the fascia transversalis, the femoral vessels take their sheath from the same membrane. Along the line of Poupart's we find the iliac and inguinal parts of the fascia joined; but on examining the disposition of the membrane in respect to the vessels as they pass under the middle of the ligament to the thigh, its continuity is traceable alone on the sheath which they protrude with them. The fore part of this sheath is mentioned as formed by the fascia transversalis, the back part by the fascia iliaca; but as these distinctions must be merely nominal, forasmuch as both divisions of the fascia are continuous not only elsewhere, but in the sheath, it is therefore unnecessary to dwell upon them. In form, the sheath of the femoral vessels is that of a funnel, and surrounds them on all sides. Its broad entrance, which is more capacious than the vessels need (the surplus space being on the inner side of the vein), is beneath Poupart's ligament; thence it narrows to where the vessels get under the sartorius muscle, and here it applies itself closely to them as their outer covering. In passing under Poupart's ligament, the vessels in their sheath are supported by the horizontal ramus of the os pubis; they have the femoral parts of the psoas and iliacus muscles close to their outer side, and the pectineus muscle on their inner side, and passing behind them. Within the sheath we find septa, which serve to separate the enclosed vessels from each other. The relative position which the vessels have to each other, and to the parts which transmit the femoral hernia, is all that requires notice at present. The artery passing under the middle of Poupart's ligament has the anterior crural nerve close to its outer side in a distinct process of the sheath; and the femoral vein lying close to its inner side. The vein is in contact with the lower end of the falciform process of the saphenous opening. As the vein lies straight in this situation while the falciform process curves inwards from it to the crista pubis, a triangular interval occurs between the margin of the falciform process internally, Poupart's ligament above, and the vein externally. This interval is lined by a process of the sheath forming a compartment distinct from that of the vein; it gives passage to the femoral lymphatics entering the abdomen; and it is through this compartment that the femoral hernia is transmitted from the abdomen to appear at the saphenous opening. This portion of the sheath is named the "femoral canal," and of its inner side the "fascia propria" of the hernia is formed. The canal widens upwards from the lower cornu of the falciform process to beneath Poupart's ligament, where this structure and a process of it (Gimbernat's ligament attached to the pectineal ridge) bound it anteriorly and internally, while the os pubis is behind it and the vein to its inner side. The entrance of the canal so bounded is

FIGURES OF PLATE XXVIII.

Fig. 1. A, Anterior spinous process of ilium.—B, External oblique muscle.—C, Internal oblique muscle; c, its aponeurosis on the rectus muscle.—D, Transversalis muscles; d, conjoined tendons of transversalis and internal oblique.—E, Transversalis fascia, forming e, the internal spermatic fascia.—H, Crest of pubis.—I, Anterior crural nerve.—J, Femoral artery,—J, Epigastric artery.—K, Femoral vein.—L L, Falciform process of saphenous opening.—M, Sartorius muscle.—N, n, Sheath of the femoral vessels opened.—O O*, Fascia lata.—P, Poupart's ligament.—P, External abdominal ring.—Q, Adductor longus muscle.—R, Iliacus muscle.

Fig. 2. Corresponding parts lettered as in Fig. 1.—E, Transversalis fascia divided at internal ring.—F, Peritonæum at internal ring.—G, Rectus muscle.—1, 2, 3, 4, Spermatic vessels and vas deferens bending over.—J, The epigastric artery at the internal ring.

called the "crural ring." On examining its upper end with the finger, we feel the canal has no communication with the abdomen; it cannot have in the natural state of the part, for the subserous tissue and the peritonæum are drawn across it; and hence, before the bowel can descend through it, both membranes must be either dilated or ruptured. On comparing the crural ring with the saphenous opening, it will be seen that of the two, the former, owing to its being of much smaller area, and to its being bounded by much more unyielding structures, is the more likely to be the seat of stricture in hernia. While the parts hold as yet their normal relative position, the close proximity of the crural ring to the external abdominal ring should be well observed, for they are only separated by the width of Poupart's ligament.

Proceeding with the dissection of the inguinal region, we have next to detach the fascia transversalis from the peritonæum, and this may more easily be effected at the internal ring or mouth of the funnel-shaped sheath of the spermatic vessels. Between those membranes we find the subserous cellular tissue connecting the two. In the neighbourhood of the ring, this subserous tissue is generally more abundant than elsewhere. It is described by Scarpa, (Sull' Ernie) as forming here an investment for the spermatic vessels inside the funnel-shaped sheath, and especially as assuming this form in old inguinal herniæ, when it is sometimes mixed copiously with fatty tissue. In it is to be found imbedded, the "infantile cord," which is the impervious remains of the serous tube, which originally led from the abdomen to the tunica vaginalis and which will be considered in connexion with congenital hernia. On dissecting the subserous tissue carefully, from the internal ring, we now find the peritonæum drawn across this part so as to close it completely, and render the inguinal canal, (like the femoral canal) a place isolated, not only from the general serous interior, but from all other places in the abdomen, and hence it must be evident that before the bowel, which is immediately applied to the peritonæum, occluding the ring, can be received into the canal, it must either rupture that membrane or dilate and elongate it in the form of a sac. While examining the disposition of the membranes at the ring, we may also view the relative position of the adjacent vessels. The epigastric and spermatic vessels are situated, like all the others of the abdominal parietes, between the two membranes, as may be ascertained by tracing them throughout their course. The exact position which they hold in respect to the internal ring, is a point of much importance, for the various forms of inguinal herniæ are described and operated on in reference to them. The epigastric artery arises from the femoral, either close above or below Poupart's ligament, and in either case ascends the inguinal wall in an oblique course, towards the navel. Soon after its origin it applies itself to the inner border of the internal ring, but being beneath the fascia transversalis, the artery can afford no support to that membrane in which the ring is formed. I mention this fact particularly, for, as we shall afterwards see, it is hence possible for a hernia to enter the internal ring, and yet have the artery *external* to the neck of its sac—a circumstance which could not happen if, as I once believed, or as some yet may, the artery supported the inner border of the ring, by passing superficial to the membrane in which it is formed. Where the spermatic vessels are about to enter the inguinal canal, through the internal ring, they cross the epigastric vessels on their outer side; and both sets of vessels being here on the inner side of the ring, pass from this place of their contact in opposite directions to their respective destinations—the epigastric vessels upwards and inwards, ramifying in the abdominal parietes as high up as the epigastrium, where the artery anastomoses with the terminal branches of the internal mammary,—the spermatic vessels downwards and inwards to the testicle. This relation of the vessels to each other, and to the ring, never varies; at least those anatomists who have recorded the varieties of all other vessels, do not mention an instance where the spermatic vessels entered the ring on the *inner* side of the epigastric, and yet this is not anatomically impossible.

Directing attention next to the posterior surface of the groin, it will be observed that at the situations where the vessels, nerves, and muscles pass to the limb, the peritonæum is reflected from them to the parietes in such a way as completely to seal all apertures. But opposite these the membrane is comparatively unsupported; and, moreover, the form of the inguinal concavity is itself such as to point intestinal pressure against those places. The iliac artery, approaching Poupart's ligament at right angles, gives off, just as it is about to pass under the middle of that structure, two principal branches—the circumflex iliac taking the direction of the iliac spinous process, and the epigastric, that of the navel. The epigastric artery divides the inguinal concavity into two fossæ—an internal and an external one, the former of which is the smaller, owing to the course of the vessel being upwards and inwards. Being more prominent near to its origin than elsewhere, the epigastric artery raises the peritonæum into a crescentic fold—a feature made still more evident by the cord of the obliterated umbilical artery when side-long with that vessel, and thus both fossæ are rendered deeper below than above—their deeper parts corresponding, therefore, exactly with the abdominal rings on either side of the epigastric artery, and affording lodgements for the viscera.

When the peritonæum is dissected off, we find the inguinal and crural rings masked by the subserous cellular tissue. The manner in which the fascia transversalis transmits the spermatic and femoral vessels, appears as already described. Inside the iliac vessels and their epigastric branches we observe a space bounded by those vessels externally, by Poupart's ligament attached to the os pubis below, and by the margin of the rectus muscle internally. This space is the triangle of Hesselbach: its centre corresponds with the external inguinal ring; and defending that opening, we find stretched across the space a dense fibrous substance consisting of the united tendons of the transversalis, the internal and the external oblique muscles. This conjoined tendon (of which Poupart's and Gimbernat's ligaments may practically be regarded as inseparable parts) is attached to the spine and pectineal ridge of the os pubis, and in some instances reaches as far outwards as the iliac vein, and closely overarches that vessel. Generally it does not appear of such great transverse width, and then between it, the vein, and the os pubis the interval which occurs gives the area of the crural ring, or orifice of the crural canal. That portion of the subserous tissue which masks the crural ring is named the "crural septum" (Cloquet), from having been occasionally found of such considerable density as likely to form a barrier against hernia. Its use in this respect, however, would be of little account if other preventives failed: according to the width and the density of the conjoined tendinous structure inserted into the os pubis, we may judge how it will affect the size and passability of the external inguinal and the crural rings at the same time. If it be narrower than usual, the crural ring is by so much the wider, and the external ring less defended. If it be weaker than usual, it will, however broad it be, offer but little impediment to the escape of the bowel through either passage. When it is broad and dense it not only obstructs the external ring effectually, but also contracts the crural ring to so small a compass that the bowel cannot pass. When it admits of the hernia entering into the crural canal, it then becomes the principal cause of hindrance to the reduction of the bowel by its resistant sharp margin, which can only be overcome by section. The crural ring being formed between the os pubis below, the iliac vein externally, and Gimbernat's ligament (which forms the border of the conjoined tendon), superiorly and internally, the line of section is of necessity always to be made in the latter direction, except when the obturator artery, derived from the epigastric, closely overarches the ring; but this is a condition rarely occurring. As a general rule, the crural ring is wider in the female than in the male, owing to the greater length probably of the horizontal ramus of the os pubis in the former. This circumstance accounts for the greater frequency of crural hernia in the female. While we view the three rings together, their very close proximity strikes attention. The inguinal canal which, between the internal and external rings measures about two inches, has the crural ring under its middle, with Poupart's ligament alone intervening. Between the adjacent borders of either of the inguinal rings and the crural, the distance, therefore, can only be about one inch; and this distance must of course be lessened when either is dilated by a hernia. Besides this mode of judging relative position, I know of no other which can answer the purpose so well. As to the elaborate scale of measurement drawn up by some eminent surgeons with a view to determine the exact position of each ring according to its distance from the iliac spinous process and the pubic symphysis, &c., surely the ever-varying proportions of individuals of both sexes and of either, must render it of little or no utility. The judgment, not the rule and compass, must be the measurer of organic nature, when we would seek a mean proportion.

In the foregoing description of the anatomy of the groin, I endeavoured to realise, demonstratively, the idea of an inguino-scrotal-spermatic canal, (reaching from the internal ring to the testicle) as naturally formed (by reason of the descent of the testicle) of *all* the layers of inguinal structures successively, from the superficies invaginated the one within the other; and all in that order giving investments to the spermatic vessels —the only exception to this, being the peritonæum, but we know that this exception does not exist in the fœtal state, and that it results in the adult only by an after process of metamorphosis.

PL. XXIX.

Fig. 1.

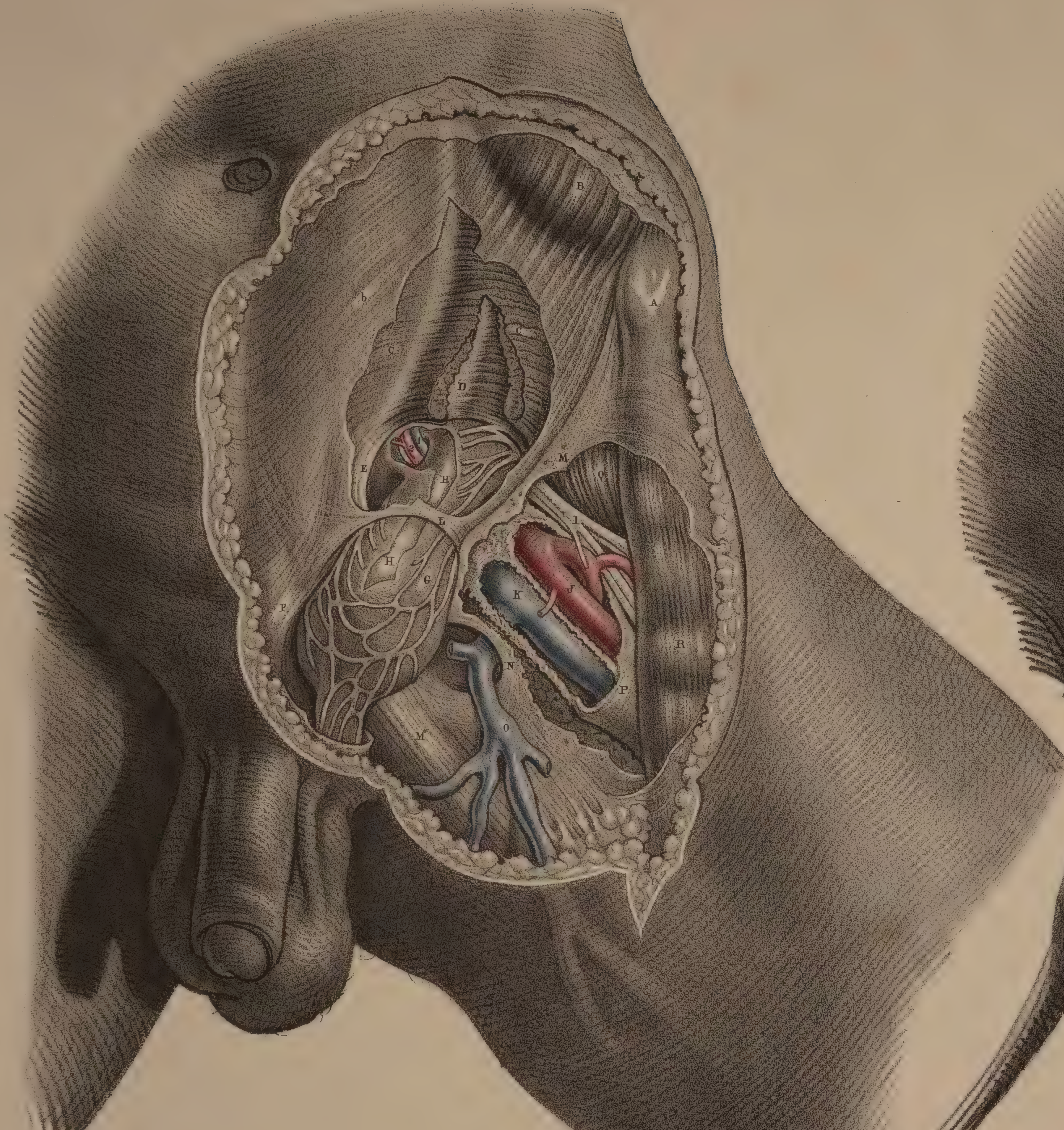
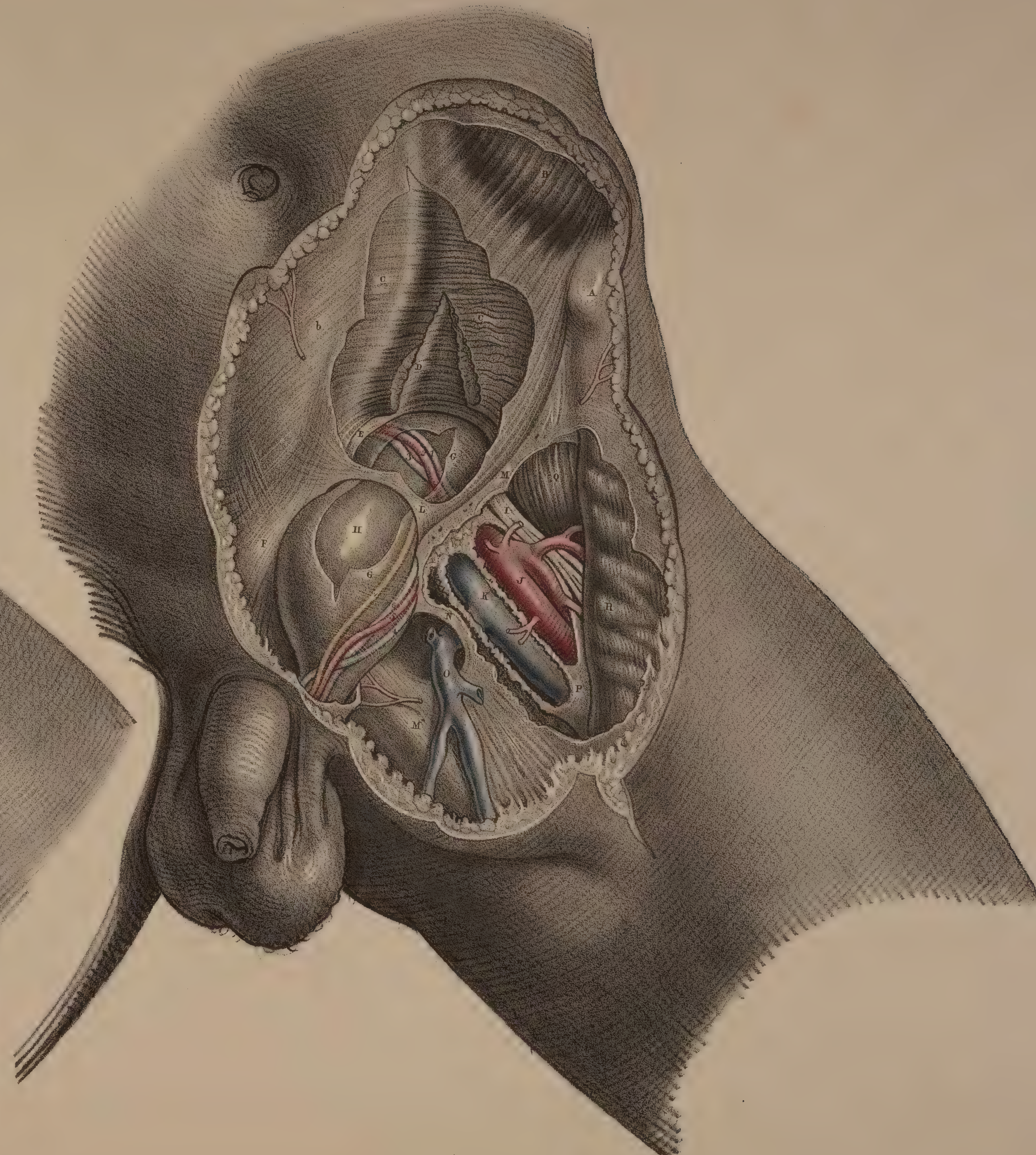


Fig. 2.



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COMMENTARY ON PLATES XXIX. XXX. XXXI. XXXII. & XXXIII.

INGUINAL HERNIA. ITS EXTERNAL OBLIQUE AND ITS INTERNAL OBLIQUE AND DIRECT ANATOMICAL VARIETIES. THEIR DISTINCTIVE DIAGNOSIS. THE SEAT OF STRICTURE. THE TAXIS. THE OPERATION.

The order in which the herniary bowel takes its investments from the structures forming the parietes of the inguinal region is, of course, precisely the reverse of that order in which those structures present themselves in the dissection from the cutaneous superficies. The innermost layer of the groin is the peritonæum; and from this membrane the intestine, when about to protrude, derives its first or immediate covering. This covering constitutes the hernial sac. Almost all varieties of inguinal hernia are found to be enveloped in a sac, or elongation of the peritonæum, especially when the hernia has been of slow and gradual formation, and when its contents consist of small intestine or omentum, or both: for as those parts hang free against the inner surface of the groin, they cannot escape from the abdomen so long as the peritonæal lining is *entire*, unless by dilating the portion of that membrane which is opposed to them. Under those circumstances, and in respect to those parts, therefore, the hernia must be always contained in a sac; and in the instances where this does not exist, the absence of it must be due to different conditions and in respect to different parts: the cœcum, which is devoid of a mesentery, and only partially covered by the peritonæum, which fixes it in the right iliac fossa, may be so forced from under that membrane as to protrude externally, without a covering of it; the same may perhaps happen in regard to the sigmoid flexure of the colon. But when the small intestine or omentum is herniary *without a sac*, this state must be owing to a *rupture* of the peritonæum occurring on sudden pressure, and allowing the viscus to pass free through the rent into direct contact with the more superficial structures. If, in such a case as this, the parts were dissected immediately after the occurrence of the accident, there can be no doubt that the peritonæum, instead of being pushed forwards by the bowel, would present a defined margin at the place where the rupture first was made. But it very seldom, if ever, happens that the parts are inspected at such a time, and consequently not until they have undergone those changes which supervene on the lesion of living structure. When those changes have been effected, the signs of rupture of the peritonæum are obliterated, and that membrane then appears as if it had been dilated before the bowel, for it is now continuous with a sac of some kind, though the structure of which this is formed may never have been produced from the serous membrane at all. Now, if it be only from the presence of a sac, without regard to its kind or the mode of its formation, that we are to infer that it could not exist unless by dilatation or pouching of the peritonæum, it would then follow that as all herniæ (containing small intestine or omentum) are enclosed in a sac, so the original fault which admits of those accidents could never be a *rupture* of the peritonæum. Such would seem to be the doctrine at present entertained according to the facts as now stated. But still I think it may be asked, is this doctrine as reasonable as it is prevalent, while we have yet to inquire whether or not it is possible for a sac to be formed, similar in all outward appearance to serous membrane, and continuous with the peritonæum, though this, from having been ruptured, could never have supplied such a sac? If this be possible, and if, at the same time, the anatomy of the groin and the structure of the peritonæum so answer inquiry as to oblige us to admit the greater probability of rupture of that membrane, then it is evident that even the presence of a sac cannot unsettle that conclusion. The manner in which the hernia affects the peritonæum, whether by dilatation or by rupture, need then no longer be a moot question, for a sac would exist in either case.

As to its physical characters, the peritonæum exhibits no appreciable difference in the living or the recently dead subject. In both it is equally resistent, extensible, dilatable and lacerable on excess of pressure. Its elasticity is a property manifested in no very marked degree beyond that of fibrous membranes. The skin is much more extensible than it, and so likewise is the common cellular membrane. The degree of distension to which the abdominal parietes are normally subjected is, perhaps, the full limit which the peritonæum, under sudden pressure, can admit of without lesion. It is true that, in ascites and pregnancy, the membrane undergoes a very great increase of surface, but then the *whole* membrane under pressure can, by reason of its large extent in duplication, allow of that increase, which would not be possible with any single small part of it; and, moreover, the distension of it as a whole is effected not suddenly, but in a very slow and gradual manner. The dilatability of the peritonæum in the formation of a hernial sac cannot, therefore, be judged of by inference from such cases; for these and herniæ do not affect the membrane under analogous circumstances. A viscus is forced against a part of the peritonæal parietes, seldom more, and frequently less, than an inch in circumference; and of this portion of the membrane we are (under the supposition of its remarkable property of distension) taught to believe that the hernial sac is formed. But when we compare the size of the abdominal entrance of even a small hernial sac (bubonocele) with the superficial extent of its interior, we find so great a disparity between them that, even admitting such a capability of the peritonæum for distension as would be only short of the fabulous, we cannot reasonably vouch it as a possibility that so small a part of the membrane could yield so large a sac. And while this is the case in reference to a hernial sac in its first stage of formation, how much more forcibly does that conclusion seem deducible from the instances of scrotal hernia, which, though originating like a bubonocele, attains, in process of time, such magnitude as to be little less in capacity than the abdominal chamber itself. Yet scrotal herniæ are furnished with sacs of serous character, forming the immediate investment of the bowel just as in the first stage of their production. While such broad contrasts of pathological conditions as that of a bubonocele and the largest-sized scrotal hernia are under notice, it is little to be wondered at if the doctrine of sacs formed only by peritonæal distension should seem untenable. And accordingly, those who adhere to that doctrine find it to require support, and assume either an increase of the sac by successive protrusions of the peritonæum at its neck, or by a growth of the sac from interstitial deposit. Both those modes of increase are, however, not such as the state of the parts would induce us reasonably to credit. If the peritonæum, as the inguinal lining, were loosely plicated instead of being, as it is, laid evenly adherent to the other parts, one might believe an extension of the sac as possible by an unfolding of the membrane, but not otherwise: and as to the growth of the small pouch of a bubonocele to a capacity so great as it oftentimes attains, this belief cannot be better founded than the one that, in a case of thoracic aneurism protruding externally, the actual coats of the aorta are still to be discerned as having undergone dilatation or growth to that extent. In such an aneurism the parietes of its sac have been successively formed

FIGURES OF PLATE XXIX.

Fig. 1.—External inguinal hernia.—A, Spinous process of ilium.—B, External oblique muscle; b, its aponeurosis.—C C, Internal oblique muscle divided.—D, Transversalis muscle.—E, Conjoined tendon.—F, Spine of pubes.—G, Cremaster and fascia propria investing the hernia.—H H, Hernial sac.—I, Anterior crural nerve.—J, Femoral artery.—K, Femoral vein.—L, External inguinal ring transmitting the hernia.—M M, Fascia lata. N, Saphenous opening.—O, Saphena vein.—P. Sheath of femoral vessels.—Q, Iliacus muscle.—R, Sartorius muscle.—1, 2, 3, Epigastric vessels.

Fig. 2.—Internal inguinal hernia—other parts lettered as in fig. 1.—G G, Fascia propria investing the hernia.—H. Sac of the hernia.—4, 5, 6, 7, Spermatic vessels and duct.

of every structure with which, in its progress, it came in contact; and so may we infer it to be with the sac of a hernia. The analogy between both cases is not overstrained: in the case of aneurism we have the blood under pressure of the heart forcing the coats of the artery, and dilating these to such a degree of tenuity that they must of necessity be ruptured, but that adjacent structures supply their want by forming the parietes of the aneurismal sac. In the case of hernia we have the bowel, under pressure of the abdominal walls, forcing the peritonæal lining, and, if not rupturing this at the first effort, dilating it to such an extent that, weakening, it must finally suffer rupture, and give place to other structures for forming the hernial sac. While, therefore, as it would seem, the peritonæum is of that quality which can sustain but a limited amount of pressure, and while, moreover, whether it be ruptured by force of the first, second, or third degree, we cannot then regard the sac, as it presents itself entire in dissection, to have been formed by dilatation of that membrane, it is clear that, whereas the sac nevertheless exists in all cases after a time, its formation must depend on other circumstances, and these appear to me to be the following: The bowel, under pressure, either ruptures the peritonæum at first, or, after forcing that membrane to yield before it to a certain limited extent, ruptures it ultimately, and comes into contact with the more superficial parts. Those parts are then, by contact with the bowel, subjected to a process by which their original surface-character is changed for that of the organ to which they are opposed. The pressure of the bowel and its serous secretion serve to smoothen and lubricate those structures; and thus they become, to all outward appearance, assimilated to it. In this manner the bowel becomes the maker of its sac, and fits itself according to the volume of its protrusion. Such a sac is therefore to be regarded not as a production of the peritonæum, but as an adventitious addition to that membrane. As such, therefore, it must be evident that the reduction of it with the herniary bowel into the abdomen is in all respects contraindicated; for as the peritonæum never furnished a quantity of itself equal to the volume of the hernial sac, so that membrane does not require such a quantity to be restored to it. To sum up, then, I would say that the name "*rupture*"—a name which agrees with the experience, from sensation, of all who are the subjects of hernia—may be taken in a more literal meaning than is generally agreed to. For convenience sake, however, I shall, in the description of hernia, regard, as usual, the sac as if it were a production of the peritonæum, since, whether this be the mode of its formation or not, the two membranes are always continuous at the abdominal rings.

All herniæ which originate in the groin above Poupart's ligament are named *inguinal.* Of these, different varieties are recognised, owing to the particular parts of the groin where they first appear, and also from certain congenital anatomical peculiarities. When the bowel enters the inguinal canal by the internal abdominal ring on the outer side of the epigastric artery, the hernia is *external inguinal;* and as it takes the direction of the canal inwards and downwards to the pubes, it becomes *oblique;* while yet within the canal it is *incomplete*, or bubonocele; when it protrudes through the external ring it is *complete*, and when it has reached the testicle it is *scrotal.* When the bowel forces the inguinal wall on the inner side of the epigastric artery, and appears immediately through the external ring, the hernia is *internal, direct, and complete;* and having descended thence to the testicle, it also becomes *scrotal.* The congenital hernia, so named from its occurring in consequence of the peritonæal spermatic canal remaining abnormally pervious after the testicle has descended to the scrotum, is necessarily always of the external oblique kind; but a direct internal hernia can never be ascribed to that original defect, even when co-existing.

The external inguinal hernia, when about to be formed, forces the peritonæum at the external peritonæal fossa, and carries before it, through the internal ring, an investment of that membrane into the inguinal canal. In this incipient stage the hernia in its sac is altogether external to the epigastric and spermatic vessels. In this and all further stages the bowel is separated from the vessels by its enclosing sac; and this, with them, is invested by all those layers of structures of which the inguino-scrotal spermatic canal is constituted. The bubonocele, now passed through the internal ring, points at first midway between the iliac spinous process and the pubic symphysis, and continues to increase; but as its further progress from behind directly forwards is arrested by the tense resisting aponeurosis of the external oblique muscle, this structure changes its course to that of obliquely inwards and downwards in the direction of the external ring. In this stage of its progress the only part of the hernia which can correctly be described as external in reference to the epigastric artery is the neck of its sac; for the elongated body of the hernia is now actually on a plane anterior to that vessel, and in respect to the median line, internal to it. Moreover, as the hernia bends in front of the epigastric artery, this vessel is separated from the anterior wall of the inguinal canal at an interval equal to the diameter of the neck of the sac. The relative position of the spermatic vessels is not affected in the same manner as that of the epigastric during the progress of the hernia. As the spermatic vessels bending over the outer side of the epigastric are internal to the neck of the hernia, so this, descending in their course, must be in front of them, even when it reaches to as low a level as the testicle in the scrotum. This position of the spermatic vessels may be regarded as constant in respect to the middle and upper parts of the herniary sac, but not so as regards its lower part. When the hernia is scrotal, of long standing and large size, the spermatic vessels are liable to be sundered from each other by the fundus of the sac, so that some of them are on its fore part, others on its outer side; but on tracing them from the testicle upwards, they will always be found to wind towards the posterior surface of the sac at the situation of the external ring. However large the hernia may be, even when it is scrotal, the testicle is invariably below it. This position of the testicle may be accounted for anatomically: the envelopes of the spermatic vessels are attached so firmly to the coats of the testicle as to prevent the hernia from either distending and elongating them to a level below this organ, or from entering the tunica vaginalis. Such being the condition of the parts in connexion with the ordinary form of external inguinal hernia, there can be no difficulty in determining the proper line of incision in an operation. If the parts superficial to the hernial sac were divided along its middle from opposite the internal ring to the scrotum, neither the epigastric nor spermatic vessels would be injured.

In the female, the external form of inguinal hernia is comparatively rare. When it does appear in this sex, its position, investments, and course through the inguinal canal, where it follows the round ligament of the uterus, are the same as in the male. And even when the hernia escapes through the external ring of the male and of the female, its anatomical relations differ simply according to sexual peculiarities of form. In the male body, the testicle and spermatic vessels, which in their descent have carried before them tubular productions from the several layers of inguinal structures, have, as it were, already marked out the track to be followed by the hernia, and prepared for it the investments; so that, whether it be within the inguinal canal or the scrotum, or at an intermediate situation, the same kind of structures cover it. In the female, the hernia, having passed through the external ring, from which no spermatic cord depends, lodges in the labium pudendi; but when we compare the anatomy of hernia in this sex with that of the other, this appears the only distinguishing feature between them. The investments which the testicle has already prepared for the hernia in the male are attained, in the female, of the very same number and kind, by the hernia itself imitating the descent of the testicle. This, indeed, might be inferred to be the case, even if dissection had never proved it to be so. When the bowel forces the peritonæum at the internal abdominal ring of the female, and carries forwards a sac from that membrane, it takes a second covering from the tubular process of the fascia transversalis, which follows the round ligament, and then, traversing the inguinal canal, it loosens and extends before it the fibres of the internal oblique and transversalis muscles, and thus obtains a cremasteric envelope, which protrudes on it through the external ring, the borders of which latter also give off to it a fibrous covering, and enclosing all the others, is to be found the superficial fascia, &c. The anatomical identity as to relative position and investments being thus not only possible, but actually appearing in the external inguinal hernia of both sexes, the difference as to the frequency of its occurrence must be due not to the absence of any of the defensive parts in either, but to the less efficiency of the structures in this character. The muscular parietes of the male groin, from which the loose cremaster is already formed, have from this circumstance become weakened, and rendered more so by the testicle having derived for the spermatic cord envelopes from all the other structures likewise. But in the female groin, where no such process has occurred in early life, the bowel under-pressure is the more resisted by the parietes when fully developed, being then compact at the point where they transmit only the uterine ligament.

The internal inguinal hernia is formed at the triangle of Hesselbach, corresponding with the internal peritonæal fossa. The bowel at this situation forces the peritonæum at once directly forwards through the external ring, and carries an investment of each of such other structures as are here opposed to it. The external ring being opposite the centre of the place where the bowel derives its sac, the protrusion of the hernia is therefore direct, and, as such, although appearing through the groin at the external ring, which also transmits the external hernia, cannot in any case have the same anatomical relations as the latter, either as

Fig 1.

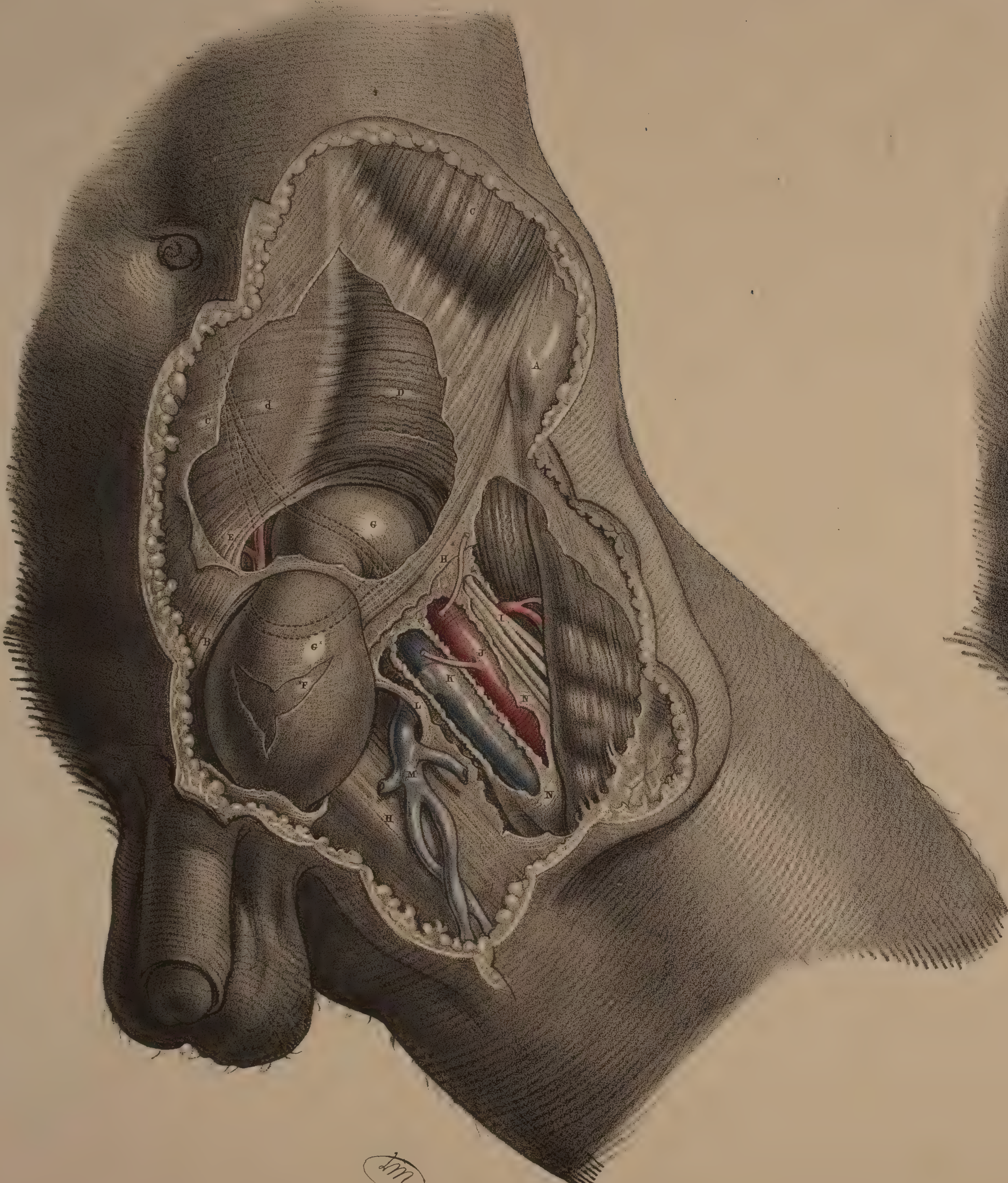
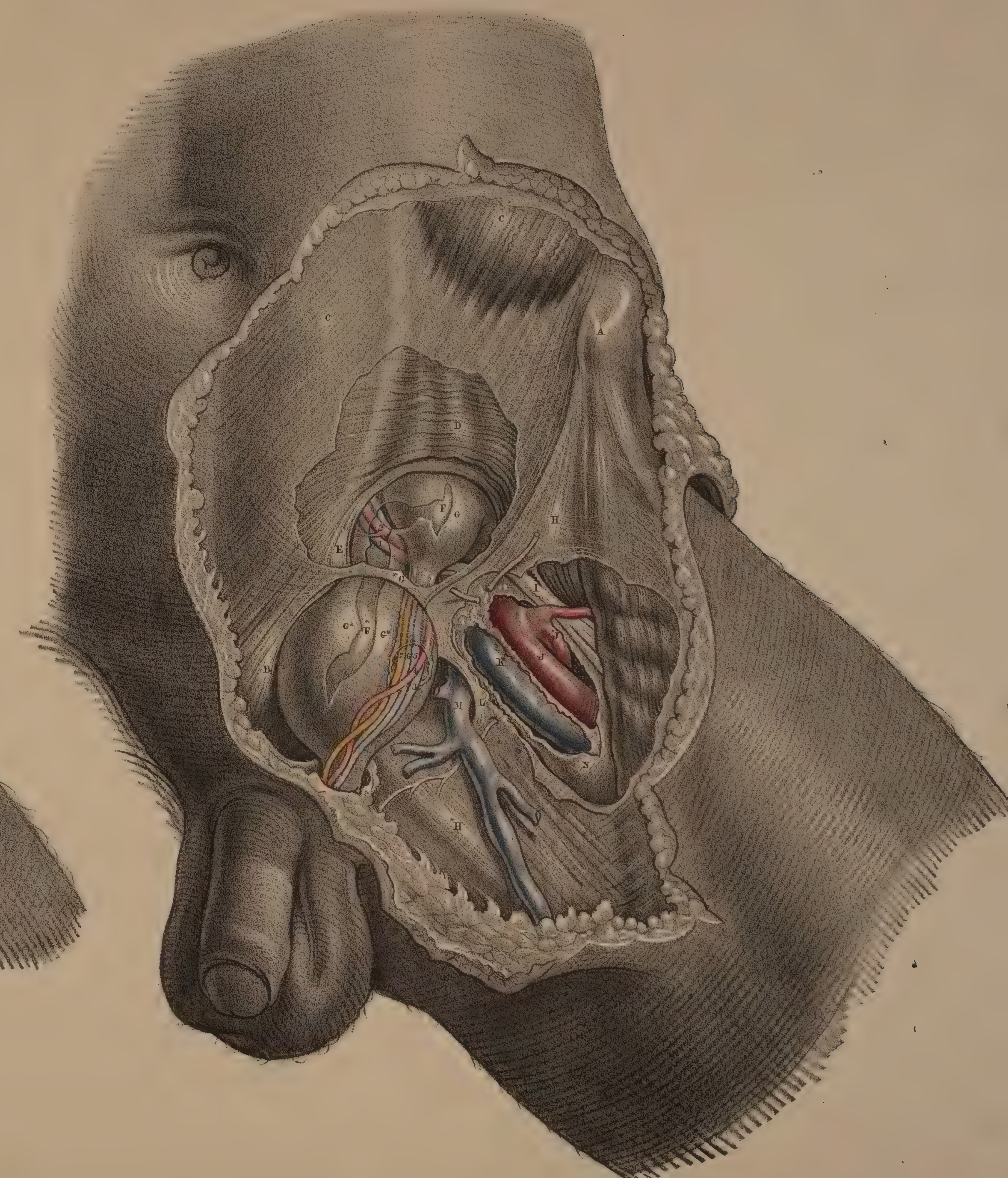


Fig 2.



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regards the inguinal canal, the epigastric, or the spermatic vessels. Unlike the external hernia, which bends from outside those vessels to take a position in front of them, the internal hernia, passing directly through the groin on the inner side of the epigastric artery, has this vessel always outside the neck of its sac, either in close connexion with this part, or at some distance from it, according as the neck is wider or narrower than usual; whilst the body of the sac, from the neck forwards, is altogether free of that vessel, and, from the first to the last stage, situated between it and the pubic median line. The relative position which the spermatic vessels have in respect to this form of hernia, may be inferred from the anatomy of the parts concerned: the spermatic cord, approaching the external ring from the outer side of the epigastric artery, and the hernia, passing through that ring directly from behind and on the inner side of that vessel, it must happen, (as it always does) that the cord is either external to, or behind the hernia, throughout all stages of the development of the latter, even to where it becomes scrotal. In the same degree, therefore, that the hernia distends the external ring, the cord will be found separated from the crista pubis, and constricted between the adjacent outer sides of the ring and the hernia. Above the external ring, the cord, passing in the direction of the inguinal canal, parts from contact with the hernia; but below the ring, the cord, becoming stretched upon the outer side of the hernia, when this is of large volume and scrotal, we find that the spermatic vessels are liable to spread and to be separated from each other. With regard to the position of the testicle, it varies according to the volume of the hernia and the manner in which this affects the inguinal canal. If the hernia be small, the testicle will depend below it; if large and scrotal, the testicle may be either on its outer side or behind it. As the coverings of this hernia, though being of the same kind as those which invest the external variety, are, in ordinary cases, taken from a *different* part of the groin, it is hence possible for the former to descend to a lower level than the testicle. But if it happen (as it may do so) that the internal hernia enters the inguinal canal and descends through it, thus having its coverings of the *same* part as the external variety, then the testicle will necessarily be, as in the latter case, always below the fundus of the sac. The position of the vessels being on the outer side of the direct hernia, forbids the incision in an operation to be made on that side. This caution is equally to be observed whether the hernia has entered the inguinal canal or not, for the vessels in either case will be still on the outer side of it. But there is, in fact, no necessity, in any case, for incising the parts in this situation, with a view to liberate the stricture of an internal hernia.

The investments of the internal inguinal hernia, though not derived exactly from the same locality in the groin as those of the external variety, are, nevertheless, but different parts of the same structures. While the external hernia, following the course of the spermatic vessels, may be said to have all its coverings, with the single exception of the sac, already produced for it, the internal hernia, which emerges direct through the external ring, has to form all its own. The bowel, pointing behind the external ring, takes its coverings of the structures in the order in which they are opposed to that opening; and though we number them separately, it should be remembered that they form, as it were, but a single layer, owing to their apposition and structural union: those structures are, 1st, the peritonæum, which becomes the hernial sac; 2nd, the pubic part of the fascia transversalis; 3rd, the conjoined tendon, or (according as the hernia protrudes further from the mesial line) the cremasteric fibres, which, in common with those of the internal oblique and transverse muscles, end in that tendon. When the hernia, enclosed in these structures, engages the external ring, it takes its more superficial coverings from the same parts, and in the same manner, as the hernia which descends the inguinal canal; thus the external spermatic fascia given off from the margin of the external ring forms the 4th covering, and the superficial fascia and integument the 5th and 6th. But though the structures in the normal state of the groin present themselves, in dissection, of this order and number, it does not always happen that they can be so plainly distinguished while covering a hernia; accordingly they are, especially as regards their number, variously described by dissectors. Thus, with respect to the conjoined tendon, the hernia is said, in some instances, to take an investment of this structure; in others, not to do so, but to pass through a cleft between its fibres; in others, to escape aside of its outer margin. Again, the cremaster muscle is stated by some to cover this hernia occasionally; by others, never to do so. Lastly, it is doubted by some whether this hernia is even covered, in all instances, by the fascia transversalis. Such being the difference of high opinion as to those anatomical points, one is inquisitive to know whence it arises, and to determine if the matter has, in reality, the practical import which it would seem to have.

When the parts of the groin are considered, as to their relative position, their form, their kind, and their other conditions, we may readily understand (if distension and protrusion be the manner in which the pressing bowel affects them) of what kind and number the herniary investments are or should be. The external inguinal hernia, in the inguinal canal, should have a *sac* derived from the peritonæum; a *fascia propria*, from the infundibuliform tube; a *cremaster*, from the internal oblique and transverse muscles; an *aponeurotic fascia*, from the tendon of the external oblique; and enclosing these, a *superficial fascia*. Any variation in the number and kind of these coverings cannot happen if they exist, and because each one of them is of uniform texture. Moreover, neither of them can be absent, in consequence of the hernia rupturing it and passing through the hiatus, for they are all, except the peritonæum, already protruded over the spermatic vessels. But crossing that space (triangle of Hesselbach) in which the internal hernia occurs, we find some of the inguinal layers varying in kind at one point from what they are at another, and therefore, at whichever of those points the hernia protrudes, of course its coverings must vary in kind also. Besides this, if one of those layers be present at one point and absent at another, it is evident that the number of herniary coverings must vary according to the point where the hernia protrudes. Added to those circumstances, we have the greater liability to a rupture of one or more parts, which, varying in resisting power, are opposed point blank to visceral pressure, as they are at the triangle of Hesselbach, than where they are already pouched recipients, as at the internal ring. Under those conditions, we may judge, *à priori*, how much more numerous than perhaps would be advantageous to reckon may be the varieties in respect to the coverings of an internal inguinal hernia. It will suffice to notice the more prominent ones: 1st. If the conjoined tendon be dense in texture, and so broad as to sheathe nearly the whole of the triangular space, it will be much more likely to allow, by a separation of its fibres, a hernia to pass through the external ring, than by its uniform distension. In the former case that tendon will not cover the hernia. 2nd. We might expect that the transversalis fascia, if not also the peritonæum, whilst forced through the sharp-edged cleft of the tendon, will be ruptured, in which event they would also fail as coverings of the hernia. 3rd. The absence of the conjoined tendon as a herniary covering must ensue if it be so narrow as not to defend the external ring. 4th. If the conjoined tendon be on the inner side of the external ring, the muscular fibres of the transverse and internal oblique will reach it in this place, and the cremasteric fibres will also be attached to it, and hence, when the hernia passes through the ring, it must carry forwards a cremasteric envelope. Surely we need not a confirmation of these views from the future experience of dissectors, for the matter is self-evident, as is the quantitive difference between $a+b$ in one place, and $a—b$ in another. But we have still to ask of what importance it is to the practical surgeon, and in what respect it influences his operation on the hernia?

The female is much more rarely the subject of direct inguinal hernia than the male; but why this is the case is not accounted for in the anatomy of the parts. Indeed, if the contrary happened to be the fact, it would be easier to explain it; for, together with the circumstance of the inguinal parts not generally being so developed as those

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FIGURES OF PLATE XXX.

Fig. 1.—External inguinal hernia become direct.—A, Spinous process of ilium.—B, Spine of pubes.—C, External oblique muscle; c, its aponeurosis.—D, Internal oblique muscle; d, its aponeurosis sheathing rectus muscle.—E, Conjoined tendon.—F, Sac of the hernia displacing epigastric artery to the inner side of external ring.—G, Fascia propria of the hernia.—H H, Fascia lata.—I, Anterior crural nerve.—J, Femoral artery.—K, Femoral vein.—L. Saphenous opening.—M, Saphena vein.—N N, Sheath of femoral vessels.

Fig. 2.—External and internal inguinal herniæ co-existing—other parts lettered as in fig. 1.—F, Sac of small external hernia.—F*, Sac of internal hernia.—G, Fascia propria of external hernia.—G* G*, Fascia propria of internal hernia.—1, 2, Epigastric vessels between the two herniæ.—3, 4, 5, 6, 7, Spermatic vessels with the external hernia descending in their sheaths and lying on the outer side of the internal hernia.

of the male, the space measured between the epigastric artery and border of the rectus muscle is relatively wider in the female, and hence more exposed to visceral pressure. Perhaps it is that the infrequency of the occurrence of hernia here strikes attention the more from the frequency of its happening elsewhere. At all events, the only feature which appears preventive of this hernia in the female is the smallness of the external ring compared with that of the male, the former transmitting only the uterine ligament. That the internal inguinal hernia is not so liable to occur as the external, either in male or female, is explained by the anatomy.

The external and internal herniæ having been now described separately, it remains to consider them as *co-existing*, and also as *simulating the one the other*. In both those cases we shall find that the only permanent anatomical line which in all instances divides them, is that drawn by the epigastric artery. When a hernia enters the inguinal canal outside the epigastric artery, and another hernia passes directly through the external ring, that vessel is always between both, and occupying its usual position. The existence of that vessel necessitates the existence of a distinct sac for each hernia, because it is superficial to the peritonæum. On viewing the posterior surface of the groin, in a case of double hernia, the adjacent borders of the necks of the two sacs will be observed to be separated by the width of the epigastric artery only; for generally the cord of the umbilical artery, which accompanies the epigastric, is pushed so close to that vessel, as not to increase the interval. Between the necks of the two sacs, inferiorly, will be found, closely congregated, the epigastric vessels, the umbilical cord, the vas deferens, and the spermatic vessels, passing in front of each other conversely to the order named. The abdominal inlet of the external hernia is always above the iliac artery, while that of the direct hernia is above the iliac vein, the vessels respectively being only separated from the herniary openings by Poupart's ligament. But the situation of the umbilical cord is not always that of the epigastric artery. The cord, in many instances, ascends the middle of the triangle of Hesselbach, dividing this space into two, and thereby rendering it possible for an internal hernia to occur on either side of it. If two internal herniæ co-existed, then the umbilical cord would alone separate them; and because it is (like the epigastric artery) superficial to the membrane, it would hence occasion the formation of distinct sacs. We have, then, from the anatomical disposition of the formative parts of the groin, an explanation of how three herniæ may exist in a row—one being external to the epigastric artery; another between that vessel and the umbilical cord; and another between the cord and the margin of the rectus muscle. But while the three may occur always with equal facility, as regards the peritonæum, other structures, from being disposed differently to that membrane, do not allow of this. The inguinal canal, already formed by the transversalis fascia and the other more superficial structures, readily admit the external hernia to descend it; in next degree as to facility of formation, is the hernia which arises close on the inner side of the epigastric artery and between that vessel and the umbilical cord,—for here the hernia may also enter the inguinal canal; while the hernia which forms between the cord and the rectus muscle, is that which has least facility to pass, in consequence of the interposition of the conjoined tendon. When, therefore, the cord does not divide the triangle of Hesselbach, but lies sidelong with the epigastric artery, the internal hernia will be found to arise more generally (as being the more passable place) close to the epigastric, and between this vessel and the border of the conjoined tendon; which latter, if it be narrow, will leave the external ring more accessible. But there are reasons why, in a case of duplex or triplex hernia, they should hinder the development of each other. In all instances of this kind that have come under my observation, I have noticed that only one of the two or of the three is in that stage of progress which is named *complete*, that is, passed the external ring. The *rationale* of this appears to me as follows: When two herniæ occur at the same time, one on either side of the epigastric artery, or of the umbilical cord, they must counterbalance each other while visceral pressure affects both equally; for the peritonæum and other membranes, which by dilatation envelope the one hernia, cannot allow this to progress so freely as they would if the other hernia—whose envelopes are formed from the same structures and in the like manner—did not exist. But when visceral pressure causes the one hernia to preponderate more than the other—an effect which is furthered by the greater weakness of the parts where the former occurs,—then this must take precedence, and, in the degree of its own advancement, must arrest that of the other. Moreover, while two or more herniæ may originate at the posterior surface of the groin, the first of them which traverses the external ring will guard (by occupation) that outlet against the others; so that, though three herniæ may in reality exist, only one of them will show externally. From this it would seem that the hernia which occupies the external ring is the first to have arisen; but if such conclusion does not follow from the facts noticed, it is at least quite evident that this hernia has had a quicker descent than the other, or either of the others existing. Instances of the co-existence of external and internal herniæ are not at all uncommon. They have been met with by Wilmer, Arnaud, Sandifort, Richter, and others. Our own and foreign museums furnish many examples of them. A plurality of the *same variety* of hernia is said, also, to have been met with on the *same side*: a complete and incomplete external inguinal hernia, co-existing in the same groin, is recorded by Aston Key. And Sir Astley Cooper (*Ingui. et Congenit. Herniæ*) states his having met with three internal inguinal herniæ in each inguinal region of the individual. Such cases are, however, known to be very rare; and certainly, if they were otherwise, it would puzzle us much to know where to look for this ever-obtruding interjection of an epigastric artery; for while, in its imposing character of a *tertium quid* between two herniary members, we can pronounce, with some degree of certainty, its whereabouts, it loses that character in a crowd of them. That the number of herniæ which have appeared external and internal to the epigastric artery should double or triple that which ordinarily occurs is, however, if somewhat inexplicable upon the normal condition of the formative parts of the groin, not so when their abnormal condition is considered, for we can understand a hernia arising in any place where the weakness or failure of parts renders such place indefensible and passable.

While the epigastric artery is in all cases the boundary line between the place of an external and that of an internal hernia, whether only one of the two herniæ exists, or both co-exist in the same individual, we find that the characters *oblique* and *direct*, which serve, also, in many instances, to distinguish those herniæ, are liable to be assumed by each. The bowel which enters the inguinal canal by the internal ring on the outer side of the epigastric artery bends inwards, and directing its course thence to the external ring, may be considered to hang suspended from that vessel. Subjected, thus, to the weight of the protruding bowel, and the weight increasing according to the volume of the protrusion, the artery, having nothing to sustain it but its cellular attachment to the serous and fibrous membranes, between which it is situated, yields with the hernia towards the median line. The internal ring, being in this manner brought opposite to the external one, the oblique direction of the inguinal canal between them is changed to that of straight, from behind, forwards; and the hernia, of course, undergoes the same change, appearing now as though it were originally direct, but still having the epigastric artery on its inner side. The spermatic vessels follow the artery to its new position, but in doing so they become separated from each other behind the neck and body of the hernia. This change of place of the artery, by yielding inwards before the neck of the sac, is gradual, and not fully accomplished till the hernia becomes *scrotal*. When in the scrotum, the bowel gravitates most, for here it is comparatively unsupported, the extensile envelopes constituting this bag falling before it, and the tortuous spermatic vessels unwinding themselves by its weight. In contrast with this form of hernia—which, from being oblique and external, becomes direct, though still remaining external to the epigastric artery — we have that form of hernia which, though internal to that vessel, is, at the same time, oblique, having entered the inguinal canal close to the inner side of the epigastric artery, by parting this vessel outwards from the inner border of the internal ring. On examining the disposition of the membranes and the vessel at this particular spot, we shall find that there is nothing but the interposed peritonæum and sub-serous tissue to hinder the bowel from entering the canal here. The pubic part of the fascia transversalis, and the funnel-shaped sheath of the spermatic vessels, are continuous at the inner border of the ring; and close to and behind that border the artery ascends the groin. The fascia and the spermatic sheath which is produced from it and turns inwards to the external ring, lie in contact—the sheath in front of the fascia, so that the bowel, dilating the peritonæum between the inner border of the ring and the artery, has only to unfold the fascia and contiguous part of the spermatic sheath in order to enter the canal on the inner side of the vessels, the spermatic as well as the epigastric. When entered into the canal in this manner, the bowel, in its serous sac, takes then the direction of the external ring, just as if it entered the canal by the internal ring on the outer side of the epigastric; and in both cases the bowel is separated from actual contact with the spermatic and epigastric vessels only by its serous envelope. But though the internal hernia thus actually gains access to the canal by the internal ring, its obliquity can never be so well marked

PL. XXXI.

Fig. 1.

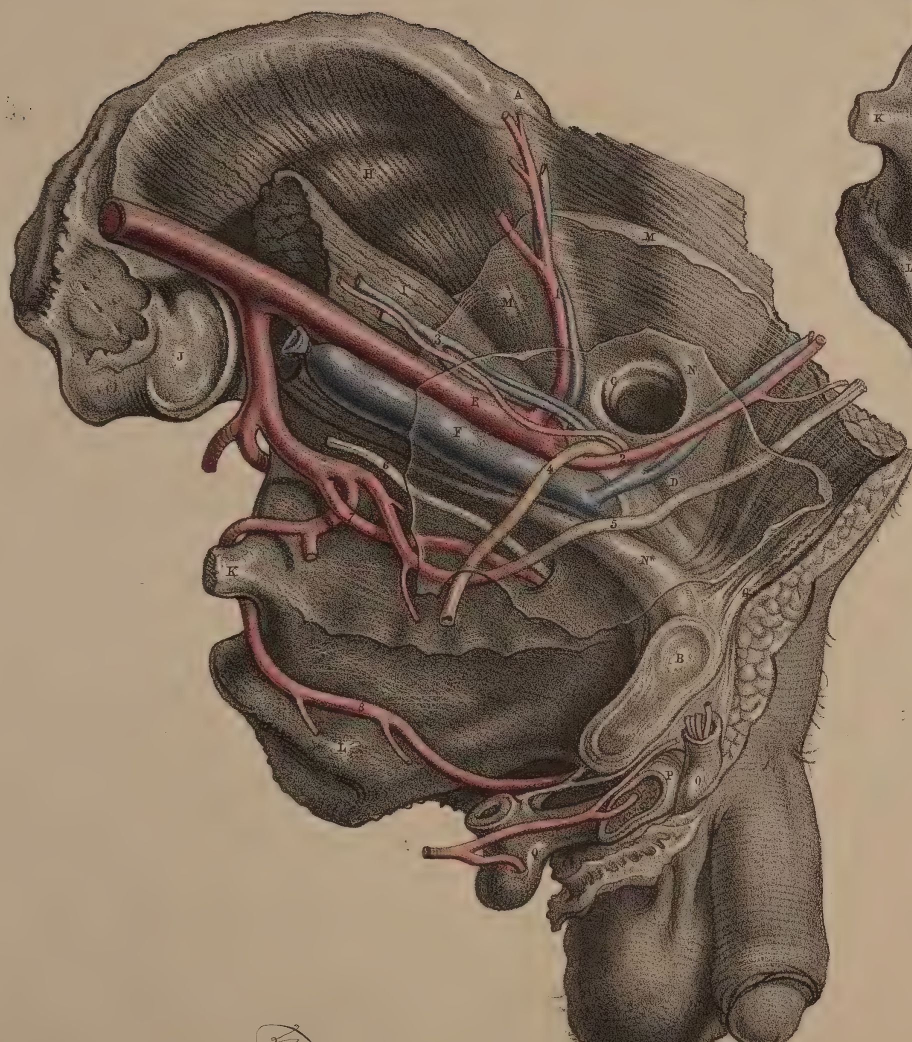


Fig. 2.

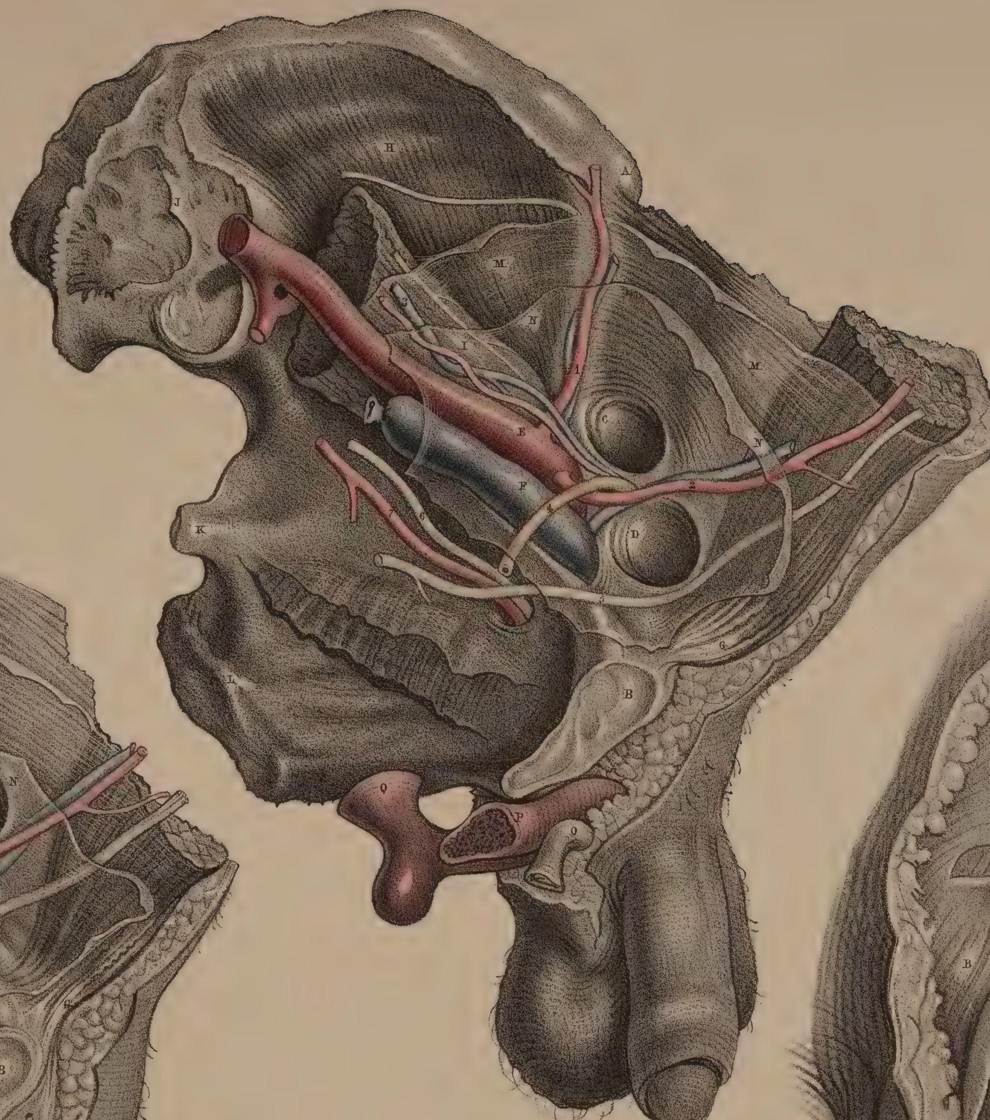
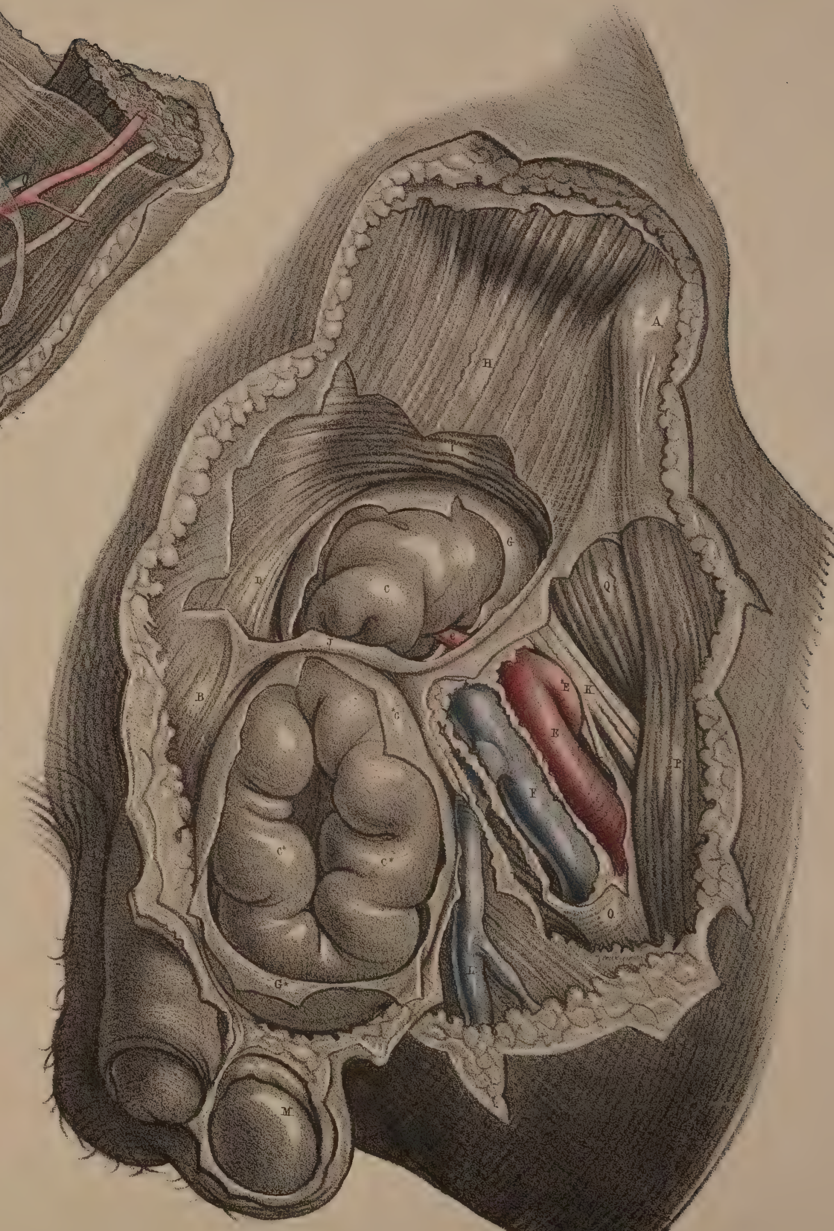


Fig. 3.



as that of the external hernia; for the latter has its neck supported by the artery on its inner side, while the former must, in order to enter the canal, part the inner border of the ring from the vessel, and in the same degree as it obliterates the fold of the spermatic sheath and pubic part of the fascia transversalis, it must shorten the posterior wall of the canal, and so appear less oblique, and, as to this feature, intermediate between the external hernia and the one which, passing through the external ring direct, does not enter the canal at all. In the case of internal hernia—which is oblique, from having entered the inguinal canal—we generally find the umbilical cord on the inner side of its neck. The epigastric artery, and the umbilical cord, having been originally separated, the interval between them is the place of the herniary protrusion. When the umbilical cord is at the centre of the triangle of Hesselbach, the hernia which occurs between it and the conjoined tendon *cannot* enter the canal; and this hernia is then truly direct, for all its envelopes are derived from the parietes of this interval, and protruded at once through the external ring, where, for the first time, the spermatic cord and it come into contact. Between the bowel of a truly direct hernia and the spermatic vessels, are interposed the envelopes of each—two sets of envelopes from the same inguinal structures.

The diagnosis of the external and internal inguinal herniæ from each other cannot, by any mode of comparison or other means, be correctly ascertained in reference to the epigastric artery, except by the signs of *oblique and direct.* And while we know that both herniæ oftentimes interchange characters in respect to those signs, a doubt must ever attach to them. The nearer the neck of the one hernia approaches the usual place of the other, the more likely, of course, are they to be mistaken the one for the other. While an internal hernia may enter the inguinal canal as well as an external one, while between the two the epigastric artery alone exists, and, moreover, while both, taking the direction of the external ring, appear oblique, the difficulty of distinguishing them must be obvious. It is only when the external and internal herniæ protrude through the groin at an interval between each other corresponding with that between the two abdominal rings, and when they thus manifest their broadest contrast, that we can judge with some degree of accuracy the place of the epigastric artery relative to either, and that the following diagnostic signs can be observed: The *external bubonocele* first occasions a fulness in the groin at a situation midway between the iliac spinous process and symphysis pubis, and above the inguino-femoral groove. This is the place of the internal ring; and the hernia, extending thence towards the external ring, dilates the inguinal canal, and, like this, appears oblique. While the hernia occupies the canal without as yet appearing through the external ring, the unusual fulness of the former part is readily perceptible, notwithstanding the restraint caused by the tendon of the external oblique muscle. Together with the fulness and tension of the canal, an unnatural elasticity of it is observable on pressure, and also a gurgling noise, from intestinal matter under peristaltic action. When the hernia has passed the external ring it dilates considerably, and assumes the form of an oblong swelling pendent in the course of the spermatic cord. On the back part of the hernia we may now feel the spermatic vessels, and trace these as far upwards as the external ring, which they enter in the same position relative to the hernia. The swollen inguinal canal above the external ring and the herniary dilatation of the cord below that aperture will now indicate plainly the oblique character of the hernia; and taking also into consideration the position of the cord and testicle, its external situation in respect to the epigastric artery may, with very great probability, be announced. The *internal hernia*, on the contrary, first manifests itself at the external ring, if the bowel protrudes directly from behind that aperture; and in such case there is no fulness or other unnatural feature about the situation of the inguinal canal. When passed through the external ring this hernia appears of a globose shape, and covers the spine and crest of the pubes. It has the cord on its outer side and sometimes spread upon its front; and in tracing the spermatic vessels to the most depending part of the hernia, this will appear as though it were not invaginated in the sheaths of the cord. The testicle, moreover, does not occupy a situation (as it does in external hernia) exactly beneath the fundus of the sac, but appears either at its forepart or its outer side corresponding with the cord. From those signs its character, as direct, is at once very apparent, and from them may also be inferred, in most cases, its internal position in reference to the epigastric artery. As to the hernia, which is internal to the epigastric artery, and yet oblique, from having entered the canal, who shall distinguish it from either of the others by any mark observable on the cutaneous superficies, or until we have the fact revealed in dissection or an operation? It is evident, however, that though internal to the epigastric, it would have the spermatic vessels outside it. But as to the hernia, which, from being originally external and oblique, becomes, under visceral pressure, direct, though still external to the epigastric artery, we have more certain means to indicate its anatomical nature, for the testicle and cord retain, for the most part, the same relative position to this hernia that they had when it was first formed; while the fact of its scrotal situation and its long standing complete the evidence of its nature. When there exist more herniæ than one the difficulty of distinctive diagnosis increases in the ratio of their number. If two oblique herniæ protrude, it becomes impossible to say which of them has the epigastric artery on its inner side. And if two internal herniæ exist, the one oblique and the other direct, it cannot be known for certainty that the artery is not on the inner side of the former. Again, if two herniæ, the one oblique and external and the other direct and internal, co-exist, and one of them be past the external ring, such a case cannot, while the parts are masked by the integuments, be distinguished by any sign from a complete external and oblique hernia; for the swelling in both cases must be of the same size and form, and appear of the same relative position. In this case of double hernia the epigastric artery would be between the sacs, holding its usual position with respect to each as when each occurs alone, that is, on the outer side of the direct hernia and on the inner side of the oblique one. But though, in the case of double hernia co-existing, a doubt must attach to the situation of the epigastric always, yet the position of the cord and testicle remains unaltered, as an indication of which of the two is complete; for if the oblique hernia were a bubonocele while the direct hernia were scrotal, the cord would be on the outer side of the latter from the external ring downwards, and on the inner side of the former from the ring upwards, through the inguinal canal. And if the direct hernia were a bubonocele, while the oblique hernia were scrotal, the testicle would be below and the cord behind the latter, just in the same way as if this existed alone. From these observations it will appear that the relative position of the testicle and cord is, though not infallibly a diagnostic sign of the anatomical variety of inguinal hernia, yet the most certain proof we possess.

Amongst those diseases which more or less simulate an inguinal hernia the following may have a brief anatomical notice: 1st. *Lymphatic bodies* in a mass might, when lying above Poupart's ligament, and inflamed, appear as a bubonocele projecting at the internal ring; but they can be distinguished from the latter by their mobility between the integument and the inguinal aponeurosis, and by the existence of ulceration of some part of the genital organs, and by the absence of visceral obstruction and herniary impulse on coughing. 2nd. *The testicle*, if arrested in any part of the inguinal canal, would cause a tumour, which might be mistaken for an incipient hernia. If the testicle were in the situation of the internal ring it might appear as an external bubonocele; if in that of the external ring, it would be where an internal direct hernia first appears. But in such a case the absence of the testicle at the corresponding side of the scrotum would be sufficient evidence of the fact as it exists. 3rd. *Psoas abscess*, when forming a tumour in the groin, is fluctuant, and always

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FIGURES OF PLATE XXXI.

Fig. 1.—Abdominal aspect of external inguinal hernia.—A, Spinous process of ilium. —B, Symphysis pubis.—C, Neck of hernial sac.—D, Conjoined tendon, &c. shielding external ring.—E, External iliac artery.—F, External iliac vein.—G, Rectus muscle.—H, Iliacus muscle.—I, Psoas muscle.—J, Sacro-iliac symphysis.—K, Spine of ischium.—L, Tuberosity of ischium.—M M, Fascia transversalis.—N N, Peritonæum.—O, Spermatic cord, cut.—P. Crus penis, cut.—Q, Bulb of urethra.—1, Circumflex iliac vessels.—2, Epigastric vessels. 3, Spermatic vessels.—4, Vas deferens.—5, Obliterated umbilical artery.—6, Obturator nerve.—Obturator artery.—8, Pudic artery.

Fig. 2.—Abdominal view of external and internal inguinal hernia co-existing.—Other parts lettered as in Fig. 1.—C, Neck of sac of external inguinal hernia.—D, Neck of sac of internal inguinal hernia.

Fig. 3.—External inguinal hernia-scrotal.—A, Spinous process of ilium.—B, Spine of pubes.—C C*, Herniary bowel.—D, Conjoined tendon.—E, Femoral artery.—E*, Profunda artery; e, epigastric artery.—F, Femoral vein.—G G*, Sac of the hernia, opened.—H, Aponeurosis of external oblique muscle.—I, Internal oblique muscle.—J, External abdominal ring.—K, Anterior crural nerve.—L, Saphena vein.—M, Testicle.—O, Sheath of femoral vessels.—P, Sartorius muscle.—Q, Iliacus muscle.

points below the middle of Poupart's ligament in the direction of the femoral vessels, and hence cannot be mistaken for any form of inguinal hernia. The matter produced from caries of the vertebræ descends, by its own gravity and by visceral pressure, always beneath the iliac part of the fascia transversalis and the peritonæum; and hence is more likely to pass through the femoral than the inguinal sheath of the fascia. 4th. *Hydrocele* of the tunica vaginalis, if this membrane be a sac distinct from the peritonæum, may readily be distinguished from scrotal hernia, even by a comparison of their forms. The summit of the hydrocele is definable in the cord, which it ascends not higher, generally, than the scrotum. From the upper border of the scrotum over the inguinal region there is no abnormal swelling; the spermatic cord can here be felt of its natural caliber, rising to the external inguinal ring, which could not, of course, be the state of the cord if a hernia had descended through it, which this must do in order to occupy the scrotum. In a hernia (not congenital) the testicle can always be felt below it, if it be oblique, and on the outer side of it, if it be direct; but in a hydrocele the fluid about the testicle prevents that organ being perceived by touch. A hydrocele is diaphanous, and allows of the testicle being distinguished as an opaque body at the back of the scrotum; it fluctuates on percussion, and does not manifest an impulse from the action of coughing, for it is isolated from the abdominal chamber at the internal inguinal ring. A hernia renders the scrotum opaque throughout, and owing to the viscus being transmitted through the inguinal ring, an impulse in it is always clearly perceptible. 5th. *Hydrocele of the spermatic cord* might cause a tumour, rising from the scrotum through the inguinal canal, and, as regards form, would thereby simulate a hernia descending through this course. In the former, as in the latter, an impulse would be felt from the action of coughing, and the more clearly and equally strong if the hydrocele, from a congenital defect of closure of the internal ring, communicated with the abdominal peritonæal membrane. Moreover, in such a state, both would at times be capable alike of reduction into the abdomen. There attend, however, a hydrocele, wherever situated, a tension and elasticity which are not of the same marked degree attending a hernia; but when the physical signs fail to distinguish them from each other, the constitutional signs serve this purpose, especially those which indicate visceral obstruction. 6th. *A hernia and a hydrocele co-existing* would mingle those signs which respectively characterise each when happening alone, and the more completely so if the hernia were scrotal. But if the hernia were a bubonocele and the hydrocele confined to the tunica vaginalis, their distinctive characters could be ascertained at the place which each occupies, for there would exist an interval between them at which the cord could be felt of its natural size. When a hydrocele exists alone it must be formed in the tunica vaginalis or in the serous spermatic tube by which that sac originally communicated with the abdominal serous membrane. But the tunica vaginalis may be of its normal character and size as an envelope for the testicle, while, at the same time, a hydrocele may be formed in the sac of a scrotal hernia, and so greatly increase the distension of the scrotum beyond what this part would present if occupied alone by the bowel, that it would give the appearance of a hydrocele of the tunica vaginalis. In this case the bowel would be immersed in the fluid of its sac, while below the sac the testicle could be distinctly felt, as in scrotal hernia, which would not be the case with that organ if the hydrocele were in its serous envelopes, or if the hernia were congenital. 7th. *Congenital hernia and congenital hydrocele* may co-exist, and render it impossible to distinguish between the two contents of the tumour by any outward anatomical feature, for their inward anatomical boundaries are the same in form and kind. 8th. *Varicocele*, in which the spermatic veins are much distended and convoluted, may be mistaken for a hernia of the oblique kind; but more frequently, perhaps, it is the hernia which is mistaken for the varicocele. A hernia of the omentum is that which most resembles a varicocele; and more than once I have seen the former (ere its nature was judged aright) about to be made the subject of the operation suitable only for the latter. The omentum is of that structure which, while it may, with ordinary powers of comparison, be known by the touch from a herniary bowel, cannot so easily be distinguished by that sense from enlarged spermatic veins. The omentum, consisting of thin layers of serous membrane, reticulated by fatty substance, may descend the inguinal canal and the sheaths of the cord in such a form and quantity as to distend those parts to no greater caliber than they would present when affected by varicocele; the tumour in both cases is uniformly cylindrical, and the plicæ of the omentum are capable of being rolled on each other between the fingers, like the distended veins. The inelastic feel which characterises omentum is not always appreciable, by reason of the presence of a small quantity of serous fluid, which makes the part the more closely imitate vascular distension; and besides this, there is, in both cases, the impulse of the abdomen almost equally perceptible, and, in the erect posture, the two similarly gravitate. In contrast with these similar states of the two, we have to judge of their difference in the effect of the recumbent posture on each: the hernia, if unurged by the hand, retains its original volume in this posture, while the spermatic vessels now unload themselves, and will resume their varicose distended state when again the patient stands erect, even though the inguinal ring be stopped by pressure. 9th. A hernia, uncomplicated with any other abnormal condition, may exist, and yet be so masked by the superficial parts, that its presence can only be ascertained by the constitutional symptoms of its strangulation. This occurs when only a small portion, or half the circumference of the bowel, is nipped by the stricture, and thus may escape notice, even when the parts are exposed in an operation.

The seat of stricture in each variety of inguinal hernia must, necessarily, vary according to the situation of the part through which the bowel protrudes. As the inguinal wall consists of many layers of structures which do not, for the transmission of the bowel, yield in all instances, the one opposite the other, so as to cause a corresponding hiatus in them directly passable from the abdomen, we have, therefore, to look for the constricting structure in *various places* in respect to even the *one* known variety of hernia. And as those several layers of structures vary as to kind, not only in different situations, but also in the same, so we have to consider the *kind* of constriction, whether as caused by membranous, muscular, or fibrous substance. When the bowel gains access to the inguinal canal, the parts which form the internal ring are stretched by the viscus; and this implies that those parts are subjected to an amount of violence, more or less, which will account for the tenderness in this situation. Though we describe the internal ring as the entrance of a funnel-shaped tube, produced through the inguinal canal from the fascia transversalis, this is not correct as to the natural form of the parts, for, in truth, neither the mouth nor the bore of that tube exists as a space unoccupied. From the point where those vessels enter the tube at the internal ring, which the peritonæum closes, to the point where they leave it to ramify in the testis, they are imbedded in cellular substance, which fills the interstices between them and the tube which encloses them; so that, when any additional organ—the bowel or omentum—traverses the interior of the tube, it must not only rupture the cellular tissue by dilating the tube from the vessels, but in its progress plough, as it were, that tissue before it. The form of the internal ring is neither circular nor oval, in the natural state; neither is the form of the tube cylindrical in that state. That which we name the ring is a mere valvular slit, sufficient to allow the passage of the spermatic vessels into that tube, whose sides (while in the inguinal canal) are rather flattened against each other and the intervening vessels. When, therefore, we consider this form of the parts which are to transmit so bulky an extraneous organ as the bowel, it must be evident that that occurrence is attended as well with rupture of tissue as with dilatation of it, whether the hernia be of sudden or of slow formation; and that, if sudden, the parts are in all instances more likely to give way by rupture. Assuming this to be the case at the internal ring, when suddenly forced by the bowel, the extent of the rupture will of course be in proportion to that part of the organ which enters the canal through it; and to a corresponding extent, also, will the spermatic tube be dilated in the progress of the organ downwards. The bowel being now in the inguinal canal, whether by rupture or by dilatation of the parts, we have the neck of its sac in the span of the fibres of the internal oblique and transverse muscles, and in the same relation to these as the upper end of the spermatic tube originally was. The external oblique hernia, therefore, whether or not it be affected with a *passive* constriction by the membranes surrounding its neck at the internal ring, may be considered as liable at all times to an *active* constriction by those muscles, the lower fibres of which, arising from Poupart's ligament externally, and becoming inserted into the conjoined tendon, to the inner side of, and behind the hernia, can thus act upon its neck as a "sphincter" (Sir Astley Cooper). It is only the hernia which enters the canal by the internal ring, which, from being surrounded by muscular fibres, can be affected with active constriction. From the internal ring to the scrotum, this hernia is, like the spermatic cord, invested by the cremasteric fibres; but these cannot act upon it in the same manner as they do upon the testicle. The next part which offers an impediment to the progress of the oblique hernia, and which, when it is passed, becomes the seat of constriction, is the external ring. The parts in which this opening is formed, being of fibrous structure, the degree of constriction which they cause to the hernia must always be of the passive kind. The dilatability of the external ring is altogether dependent upon the state of the inter-columnar fascia,

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Fig. 1.

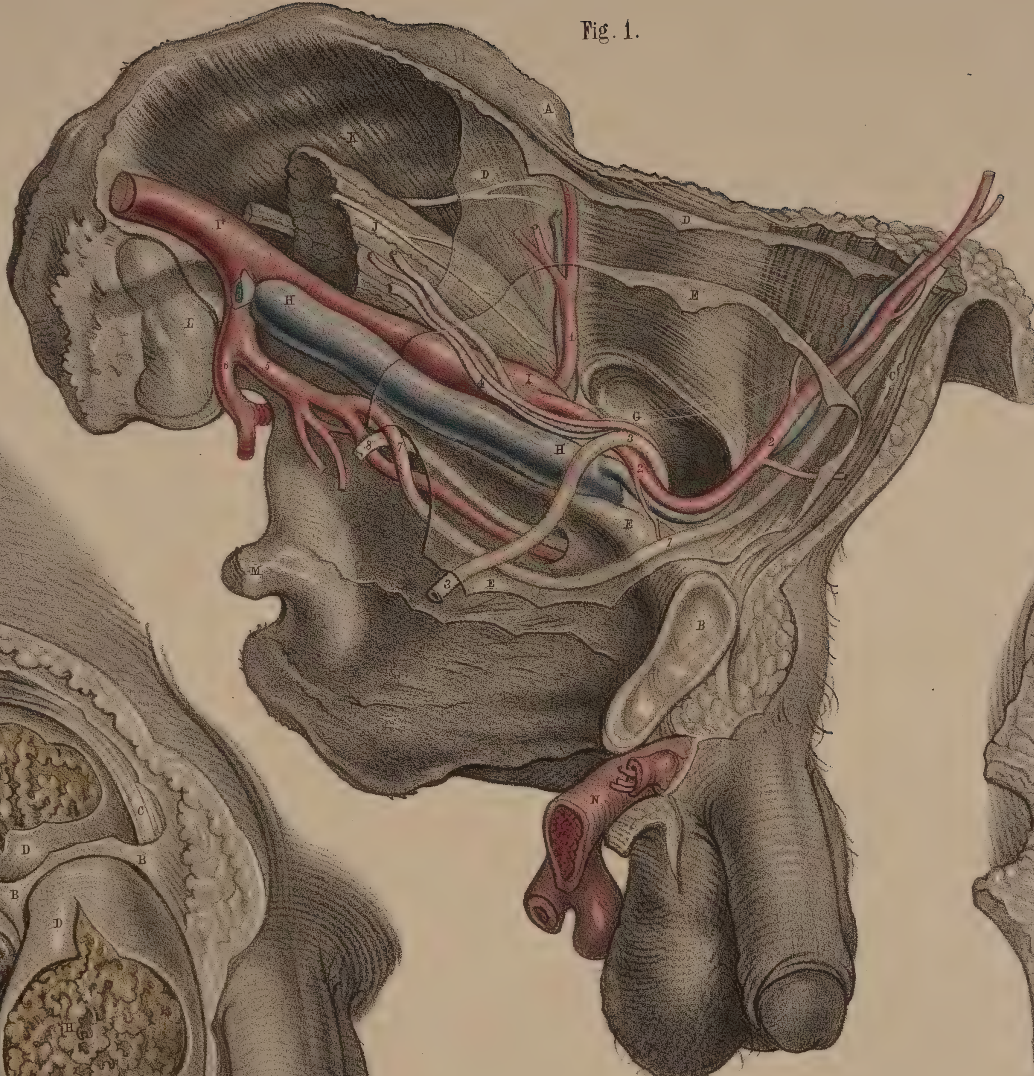


Fig. 2.

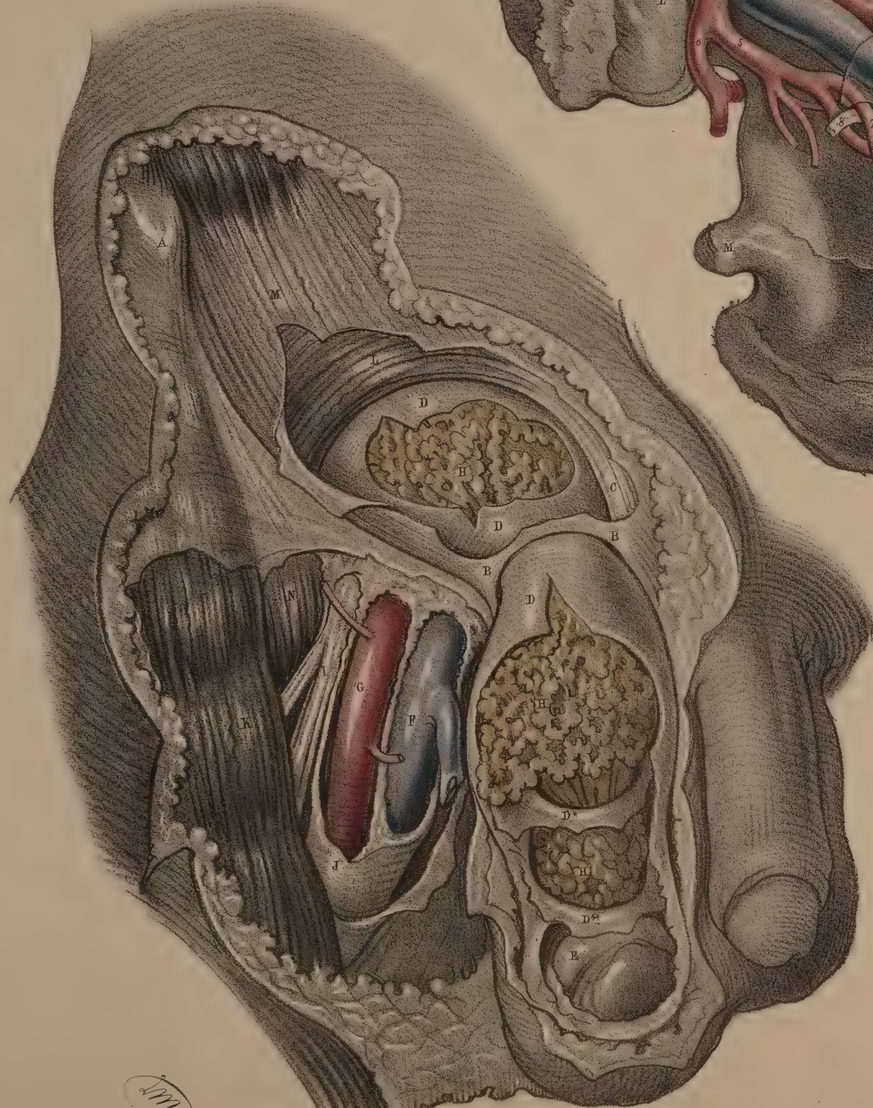
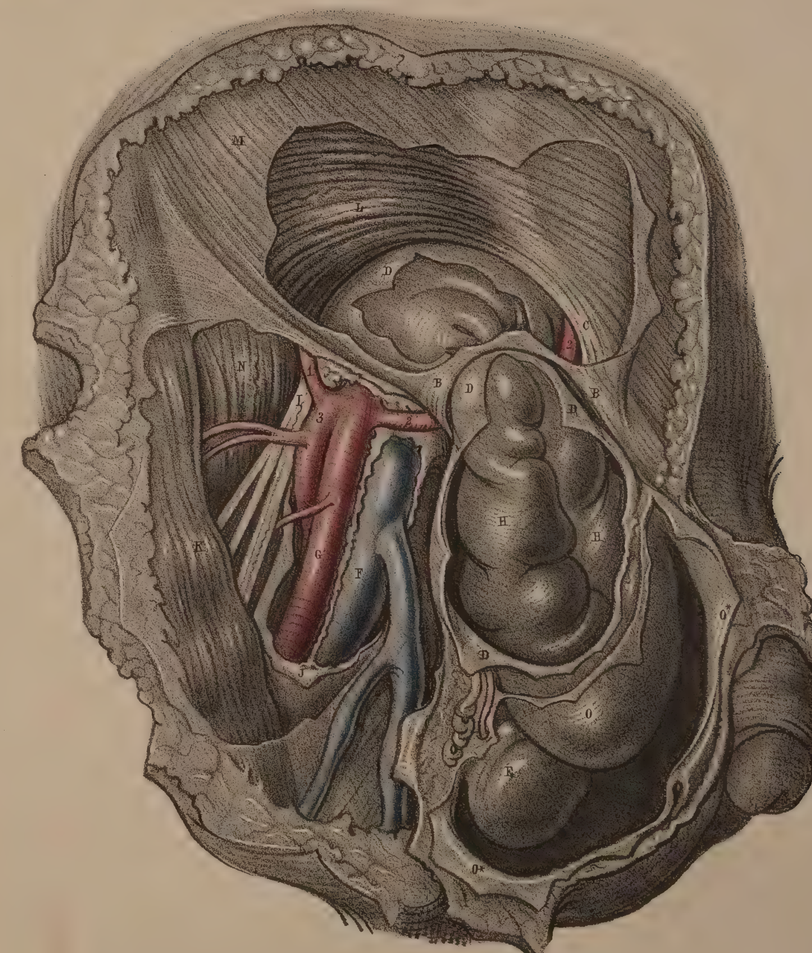


Fig. 3.



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the fibres of which bind together those which form the pillars. The intercolumnar fascia varies in strength in different individuals. When it is weak, the hernia may dilate the external ring to such a wide area, as to seem but little resisted in this place; but generally the fibres of the fascia are of such strength as to gird the hernia so tightly that it is immovable in their embrace. In the latter condition, the hernia must be subjected to much constriction by the external ring; and I have little doubt, that if all experiences were canvassed, as to whether the more usual seat of the principal constriction was the external or the internal ring, in respect to the hernia which traverses both, the former would have that verdict in nine cases out of ten. In all the instances of external inguinal hernia which I have had an opportunity of examining, there appeared, on extricating the bowel, a deeper and more permanent depression made in it where it corresponded to the external ring, than in any other situation, for it is there that the parts are most resistant, and it is there that the herniary bowel takes its *second* bend, which completes its obstruction.

In the case of internal or direct inguinal hernia, the stricture is of the passive kind; for the structures through which this hernia passes are all of fibrous tissue, or fascia. The escape of the bowel through the external ring is so immediate after the rupture or the dilatation of the structures which fence this opening behind, that the seat of constriction is always at the same place. The peritonæum, transversalis fascia, and conjoined tendon, being successively applied to each other and against the external ring, the four parts, in the same order, will be found to gird, as one and the same structure, the neck of the sac. Upon the existing state of the conjoined tendon depends in how much the external ring is to be regarded as the seat of stricture alone. If the tendon be so strong as not to be dilated by a hernia, and yet to allow of the passage of this by a separation between its fibres, then the cleft in the tendon will effect the constriction of the neck of the sac as much as, if not more than, the external ring. If the hernia escape aside of the outer border of the tendon, and has to bend inwards in order to pass the external ring, then it will be constricted between the opposite margins of the two. But if the tendon, where it should fence the ring, is weak and membranous, or absent, and that the peritonæum and transversalis fascia alone oppose the passage of the bowel through the ring, then this will, of course, be the only seat of stricture. Indeed, in the majority of instances, the external ring is the part which does principally constrict this hernia, also; for the very fact of this forming at all in this situation is owing to the weakness or absence of the conjoined tendon behind the ring. When the internal hernia is oblique, by having entered the inguinal canal, it is then, like the external oblique hernia, surrounded by the muscular fibres which gird the internal ring, and may be accounted as equally liable to active constriction by the spasm of those fibres. But perhaps this kind of constriction is much more often inferred from the anatomical condition than realised by pathological experience.

In both varieties of inguinal hernia, the neck of the sac is described as being occasionally the seat of stricture; and it certainly is so; but never from a cause originating in itself, or independently of the more superficial structures. For, supposing the sac to be formed of the peritonæum by dilatation, it is evident, that if other structures permitted, it would adapt itself to the form and volume of the protruding viscus at all situations; and the same may be said of the fascia transversalis and other membranous tissues. The form of the sac must, therefore, be influenced by the disposition of the parts which surround it; and from this circumstance it may be taken for granted, that the form of the viscus which protrudes in the sac will be, as it were, a cast of this envelope, and of the structures which include both. The neck of the sac of an oblique hernia is narrowed at the internal ring when this ring is itself narrow; but, more frequently than otherwise, the internal ring is (as far as my observation informs me) of sufficiently wide an area not to subject the hernia to any very inconvenient degree of constriction, for the parts which span it here are of a kind more readily dilatable than elsewhere. In the inguinal canal, the volume of the bowel in its sac is limited to the dimensions of this place, which, by the resistance of the inguinal aponeurosis, cannot be dilated to any marked degree beyond what it ordinarily presents. Again, at the external ring the sac becomes deeply indented, and, consequently, its contents constricted, when that opening is narrow, and not of a nature to yield. In like manner, the area of the neck of the sac of a direct inguinal hernia is limited to that of the outlet through which it passes; and hence it is clear, that if the outlet did not constrict, the neck of a hernial sac would not exist of the form in which we generally find it. All this is so obvious as not to require mention if it did not lead to practical inferences. In recently-formed herniæ, the liberation of the parts which constrict will give freedom to the neck of the sac as well as to the bowel in it. But when the neck of the sac has existed in the embrace of the constricting parts for a considerable period,—when, as a consequence of rupturing dilatation, it has suffered inflammation and undergone chronic thickening,—then, even though the surrounding parts be divided for their relaxation, the neck of the sac, being callous, as a *cicatrix*, will maintain its narrow diameter, and still of itself constrict the bowel in it. In such case, it is required to incise the neck of the sac, and not only this, but any other part of it which, from having been subjected to the like constriction, is necessarily affected in the same way. When the external ring has long been the cause of stricture, the sac here will be even more likely to present the condition now described than at the internal ring. Besides this requirement for opening the sac, others are recognised: the bowel, as a consequence of inflammation induced by constriction may be adherent to the neck of the sac, or to any other part of its interior; or firm bands of false membrane, stretching from side to side of the sac, may constrict the bowel in it; or this effect may be caused by the bowel being herniary, through a rent in the omentum within the sac; or there may be a series of indurated valvular rings, narrowing the sac at intervals and tightly embracing the contained bowel—such a condition being the supposed effect of successive protrusions of the sac from the place (internal or external ring) where, by constriction, each valve was formed. Examples of this nature are of such striking significance, as to recommend the opening of the sac in all instances, so as to examine the condition of the bowel. In some of those conditions, the bowel cannot be replaced unless the sac be opened; in others it may be, while, at the same time, its state is such, that the operation for obviating its strangulation would be unproductive of that effect. These are tangible, urgent reasons for exposing the bowel in the operation for hernia, and admitted to be such by those who suppose the danger accruing from that measure; and do not those reasons bespeak its necessity in all cases, forasmuch as they cannot be known not to exist so long as the sac is entire? But what is the structural peculiarity of a hernial sac which should forbid an incision of it? What, physiologically, anatomically, or pathologically, points to the objection? What is the recognised ill consequence assignable, particularly, to a wound of that membrane, and what can that ill be if the membrane is but an adventitious product? Is it peritonæal inflammation that we have to fear as in prospect, while this already exists by reason of strangulating visceral obstruction, which, in fact, has necessitated the operation? Why refer the effect to a mythical cause while a real one is in view?

Having now noticed, chiefly in reference to the cutting operation, the parts which constrict the hernia by the resistance they offer to it in its passage through them, it remains to be considered in what manner the bowel *strangulates itself* against those parts. In the latter point of view, the hernia will appear as much the agent of its own constriction as the subject constricted, and this will elucidate the principle on which the taxis is to be conducted. When the hernia is passing through any part of the groin, it must adapt its size to the area of the place trans-

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FIGURES OF PLATE XXXII.

Fig. 1.—Abdominal view of external inguinal hernia become direct.—A, spinous process of ilium.—B, Facet of symphysis pubis.—C, Rectus muscle.—D D, Transversalis fascia.—E E E, Peritonæum.—G, Neck of herniary sac bending epigastric artery to inner side of external ring.—H, Iliac vein.—I, External iliac artery.—I* Common iliac artery.—J, Psoas muscle.—K, Iliacus muscle.—L, Sacro-iliac junction facet.—M, Spine of ischium.—N, Crus penis, cut.—1, Circumflex iliac vessels.—2, Epigastric vessels.—3, Vas deferens.—4, Spermatic vessels.—5, Obturator artery.—6, Gluteal artery.—7, 7, Obliterated umbilical artery.—8, Obturator nerve.

Fig. 2.—External inguinal omental hernia.—A, Spinous process of ilium.—B B, External inguinal ring.—C, Conjoined tendon.—D D D, Sac of hernia.—D* D*, Rings of sac, indicating successive protrusions.—E, Testicle.—F, Femoral vein.—G, Femoral artery.—H, Herniary omentum.—I, Anterior crural nerve.—J, Sheath of femoral vessels.—K, Sartorius muscle.—L, Internal oblique muscle.—M, Aponeurosis of external oblique muscle.—N, Iliacus muscle.

Fig. 3.—External inguinal scrotal hernia with Hydrocele.—Other parts lettered as in Fig. 2.—D D D, Sac of hernia.—H, Herniary bowel.—O O O, Hydrocele of tunica vaginalis surrounding the fundus of the hernia.—1, Circumflex iliac artery.—2, Epigastric artery.—3, Profunda artery.

mitting it, else it could not pass through such place; and hence it is evident, that if the hernia, when passed, retained the same bulk as it had when passing, the parts through which it is passed could not then be regarded as a cause of its constriction, for it could be returned as readily as it egressed. In omental hernia, the part below the internal or the external inguinal ring is of no greater diameter than the part in the embrace of either of those openings, and exemplifies this point. But in hernia of the bowel, the opposite of this condition is observable. The bowel below the seat of stricture far exceeds the diameter of that in it, and is expanded as much as, if not more than, the part above it; and as this appearance is assumed by the bowel subsequently to the time when it was in passage through the girding parts, it must be regarded as due to the vital agency of that organ in its unwonted position. While the bowel is passing through the narrow space the boundaries of which are to become the seat of stricture, the viscus is compressed and corrugated, so that, for the time, its contents are pressed out of it into its adjoining parts within the abdomen, and the circulation is impeded from having access to it. The compressed bowel is then, in passage, of no more bulk than its actual structural quantity, and this is but small. But when the bowel passes beyond the aperture, it is no longer subjected to the same degree of compression, and then resumes its original form and size by the circulation, as well as the intestinal matter having now partial access to it through leave of the ring, which, by the transmission of it, has been somewhat dilated. From this date the bowel effects its own strangulation. The mesenteric arteries being of a structure more capable of resisting pressure than the accompanying veins, and the force of the arterial current being greater than that of the venous, the incarcerated bowel is still reached in some measure by the circulation of the arteries, while that of the veins is obstructed. This accounts for the congestion of the bowel—the colour of it being that of venous blood, stagnant. Besides this cause of tumefaction of the bowel below the stricture, there is the slow accumulation of the more fluid part of the intestinal matter, caused by the vermicular action of the bowels between the stricture and the duodenum; while the bowel between the stricture and the rectum may be regarded as non-continuous with the upper portion of the intestinal canal, since the bowel below the stricture is incapable of impelling its contents onwards. In every complete hernia of the bowel, there must of course be two parts of its canal in the embrace of the stricture, and from this it will be inferred that the impediment to the onward progress of the intestinal contents must tell with double effect in respect to the rectal side of the canal. The incarcerated bowel, therefore, receiving some portion of the intestinal matter from the duodenal side of the bowel, while it transmits none to the rectal side, must, from that cause, swell below the stricture and secure its own confinement. Its contents now undergoing chemical decomposition, gaseous matter is given off and adds to the distension of the bowel, rendering the hernia tympanitic; while the serous secretion, as well of the bowel as of the sac, also enlarges the bulk of the hernia, and thus we have it proved to us that, while the name "stricture" applies to the parts embracing the hernia, *strangulation* is due to the bowel itself.

The taxis, as a measure for replacing the inguinal hernia, is to be conducted according to the anatomical relations of the parts concerned in that accident. But while the anatomical principle is necessary to be observed at all times, there are other calculations no less requisite to be made, in order to render that principle effective. It is not all-sufficient for the reduction of the hernia to know in which direction to urge its replacement, if its state be such as will not admit of this, even though there be no other obstacle than that offered by the parts forming the herniary aperture. While the seat of constriction is that which is to be overcome by the cutting operation, the position and form of the bowel demand even more consideration in the performance of the taxis than the constricting part itself, for, in fact, this part is only to be commanded, as it were, by the instrumentality of the bowel; and if this rule were more often and skilfully observed than it is, I doubt not that far more frequently than we now see the taxis fail, we should find it prove that the hernia has as little needed the surgeon's bistoury as the physician's *recipe*. Regarding the subject in strait with a view to its reduction by the taxis, we have the herniary part below the stricture in a state in which it could not have possibly reached that position, for it is now of far greater dimensions than the part girt by the stricture or than the area of the space, which was only just sufficient to transmit it when of much smaller size. To return that hernia entire as it now appears through that space, while both retain their respective proportions, must therefore be acknowledged as physically impracticable, and hereupon rise the following indications: either the stricture must be overcome by an operative incision or the bowel must be reduced in size by manipulation—by the taxis. Now the latter result, it must be evident, can only be attained by compression effecting a diminution of the quantity of the hernial contents, and this should always be the first object in view while performing the taxis, for until that be accomplished it will be of no avail to direct the hernia retrograde through the course it has protruded; for though it feels elastic and impressible, yet the stricture will no more readily allow the protruding viscus to repass than if it were a solid of the same girth. So true is this proposition, that I do not hesitate to say that, in every hernia replaced by the taxis, that event has been promoted not so much by the anatomical skill of the manipulator as by the simple physical effect of a reduction in volume of the hernia by the compression of the hand. It being self-evident, then, that the greater cannot be reduced through the lesser, we have, in order to effect the reduction, to equalize the periphery of the hernia and the area of the aperture transmitting it; and as the taxis precedes the operation, let us consider the means which are in common practice for aiding manipulation in the former measure. If the seat of stricture be, as it generally is, in the unyielding fibrous tissue of the inguinal parietes, I would ask of what avail can any medicine be, whatever be its *modus operandi?* for *purgatives* cannot reach the incarcerated bowel, and *sedatives* and *nauseants* cannot affect that tissue whose organization is such as to render it incapable of active motion on its own part, and hence equally incapable of passive relaxation. Of what avail can *venæsection* be to the reduction of a hernia under those circumstances, when it can neither relax or widen the area of the apparently bloodless fibrous stricture, nor abstract blood from the vessels of the bowel whose circulation is mechanically obstructed? Again, how can the *warm-bath* be supposed to effect the relaxation of a fibrous stricture? or supposing this possible, of what avail would such relaxation be while heat, at the same time, promotes the expansion of the strangulated bowel itself and of all its contents, whether gaseous, fluid or solid? Again, while the hernia is in the tight embrace of the stricture, what *enema pipe*, of whatever length it be, even though it were to traverse the rectum, the colon, and the ilium, to the inguinal rings, can relieve the strictured bowel of its contents? These are questions so bound up in the nature of things and so suggestive of the empiricism of such treatment, that if our "practical" man, laying his right hand on the herniary body, showed me its reduction while *opiate*, *bath*, or *purgative* was in operation, I would more willingly ascribe the result to miracle than as the effect of either of such means. But in the application of *cold* as a *contractor* of bulk, and in the use of *compression* as a means of *diminishing quantity*, there is a *rationale* at once as feasible as it is always promising.

Acting, then, in concert with the simple physical principle, the anatomical one will the more likely become productive of the end in view. The recumbent posture allows the abdominal viscera to gravitate towards the back, and gives the herniary bowel a tendency in the same direction, not so much by reason of the weight of the viscus outside the seat of stricture as by the weight of that within the abdomen, which, according to the force of its gravitation, makes *traction* on the herniary part. This tendency of the hernia to follow the viscera, gravitating *en masse*, will be furthered by raising the pelvis to a higher level than the abdomen and thorax, while the relaxation of the inguinal parietes will be as effectually accomplished in that position as if the shoulders were raised. By flexing the thigh to the groin, by emptying the bladder, and rendering the diaphragm inactive, a further degree of relaxation of the groin will be effected. In the trial now to be made for replacing the bowel we have to consider the fact that the hernia below the stricturing ring is of greater dimensions than will allow of its being reduced through this strait. To lessen the herniary quantity is now the immediate object, and this can only be attained by applying to its whole superficial convexity the concave recipient palm, and urging it with a gentle, gradual, equable pressure, so as to empty the sac of its fluid and the bowel of its flatus or other contents, through the still pervious portion of the intestinal canal within the stricture. This being done, the reduction of the protruded bowel will be found to be more promoted by the *traction* of the abdominal viscera gravitating in the position in which the body is placed than by any effort of *impulsion* by the hand of the operator. I have in all cases experienced this fact myself. This traction from without inwards rather than compression in that direction will also better answer the necessity of replacing first the part of the bowel which last protruded. Rude compression, while it cannot contribute to the safe and proper reduction of the bowel, is apt to cause intus-susception; or the equally undesirable result—the "*reduction en bloc*," sac and all; or to bruise or burst the bowel against the sharp resisting margin of the fibrous stricture; or to force it into extra-abdominal situations, where, concealed, of course nothing more can have been effected than a change of place. Indeed, judging from the actual state of the herniary bowel or omentum, there is every

PL. XXXIII.

Fig. 1.

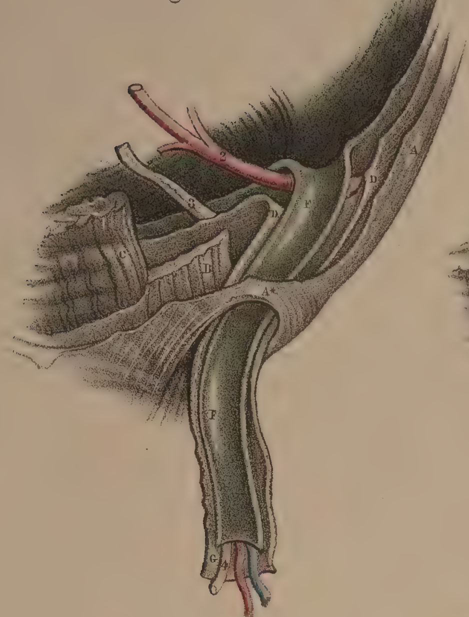


Fig. 2.

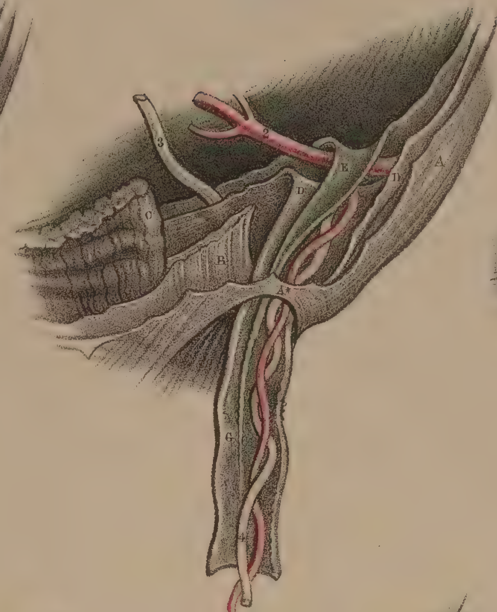


Fig. 3.

Fig. 4.

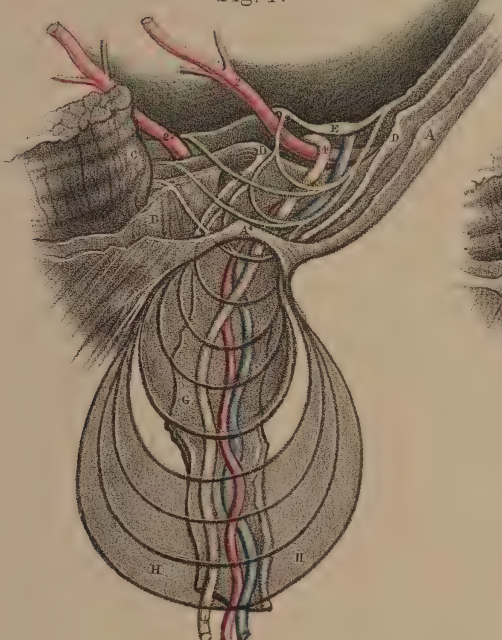


Fig. 5.

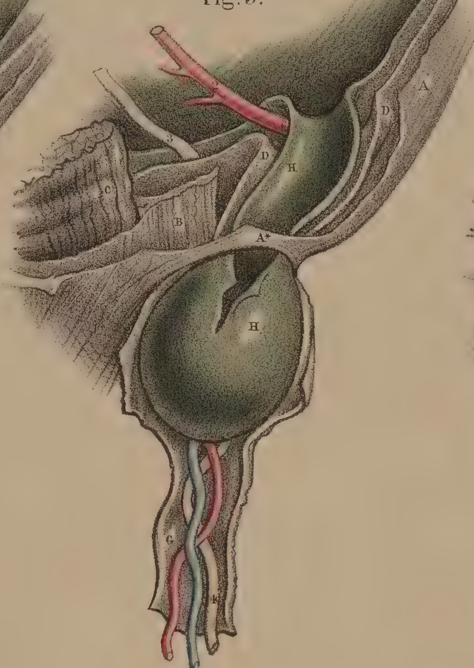


Fig. 6.

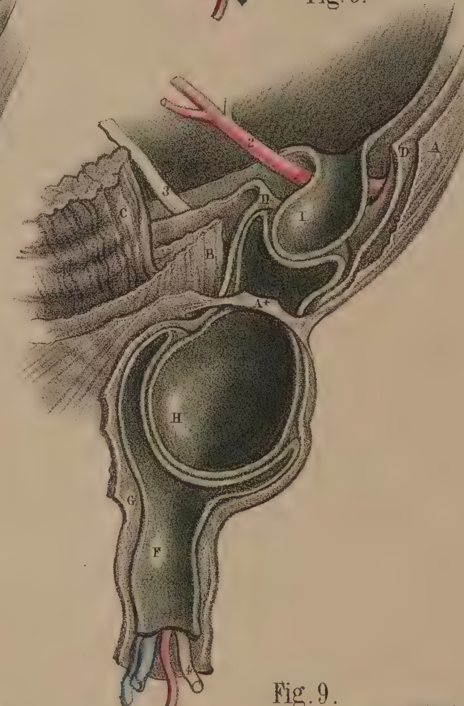
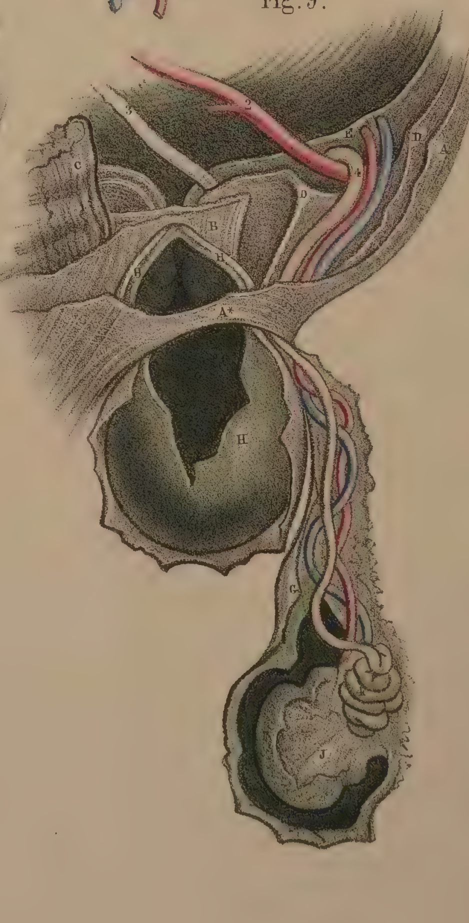


Fig. 7.

Fig. 8.

Fig. 9.



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good reason to doubt if any force, greater or less, or in whichever direction it be made, can contribute (further than by causing a diminution of volume) very materially to the replacement of the bowel. For, supposing the hernia relaxed and decreased in volume by compression, no impulsion then on its periphery can unseat its strictured neck any more than can impulsion at one end of a flaccid cord put in motion the other. In either case, it is the part only which is next the acting power that will obey that motion. But it is different with the force of *traction* on a flaccid mass; for as one part obeys this motion, so must all, from the same cause; and therefore I conceive that the reduction of hernia is rather to be attributed to the traction of the viscera gravitating according to the supine position of the body than to manual impulsion from before. Be this opinion plausible or otherwise, it will, however, be evident that, if impulsion can be of any avail at all, the direction in which the hernia protrudes must always determine the direction in which it is to be replaced. If it be the *direct* variety of inguinal hernia, pressure is to be made from *before backwards*, and this will serve equally for the reduction of that hernia which, from being originally oblique, has become direct. If it be the *oblique* variety, pressure is to be directed *upwards, outwards and backwards*, in the course of the inguinal canal; but while the principal seat of stricture is generally the external ring, it may be very reasonably believed that the portion of the hernia between this opening and the internal ring is as often not under the command of the hand.

The operation for liberating the hernia by dividing the stricturing parts is to be undertaken when the taxis fails. From experience it is taught that, when the bowel is in an actual state of strangulation, the less the operation is delayed the more hope is there for its successful issue. This, indeed, will be readily suggested by the state of the hernia and of the patient. The manipulation by the taxis cannot be borne in such extremity, because of the tenderness of the parts; and, owing to the bowel being on the verge of disorganization, it requires but little pressure to rupture it. When the general and local symptoms of strangulation appear the bowel may be considered so totally obstructed, that the taxis, however prudently performed, cannot produce a diminution of the bulk of the hernia, and therefore it may be at once concluded that its reduction by that mode is impossible. The operation for the division of the stricture in *external* inguinal hernia is to be conducted in the following way:—An incision is to be made through the integument, adipose tissue, and superficial fascia, of a length and depth sufficient to expose the tendon of the external oblique muscle for an inch or so above the middle of Poupart's ligament, and the hernia for the same extent below the external ring. The length of the incision will require to be varied according to circumstances, but ordinarily it need not be greater than sufficient to expose the constricting parts: its direction should be oblique, with that of the hernia, and also along the middle of its longitudinal axis. The depth of the incision will be greater or less according to the quantity of adipose substance existing. The only vessels which cross the line of incision now indicated are the hypogastric vein and a small artery—a branch of the superficial pudic. The spermatic vessels being behind this hernia, are out of danger. With the inguinal aponeurosis now in view, it can be ascertained in how far the hernia is constricted by the external ring. But whether or not this be the principal seat of stricture, the parts forming it will have to be divided. That the external ring, in all cases, causes more or less constriction will appear from the sudden dilatation of the hernial sac escaping from its embrace. After depressing the hernia, from the external ring, this latter is now to be divided in a

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FIGURES OF PLATE XXXIII.

Demonstrations of the Origin and Progress of Inguinal Herniæ and of the Operation.

Fig. 1.—When the peritonæum (from congenital defect) does not close the internal ring, D D, formed in the fascia transversalis, but descends the inguinal canal, D A*, as a tube, F F, within the infundibuliform fascia, D G, then the bowel may at any time enter that tube without, of course, either rupturing or pouching the inguinal peritonæum. The serous tube becomes, in such case, the immediate investment of the bowel, though not in precisely the same form of a hernial sac, as when this has been protruded by the bowel, from the inguinal peritonæum closing the internal ring on the outer side of the epigastric artery, 2. This, however, is the only anatomical point in which both those herniæ differ. Both are external to the epigastric artery; oblique in the inguinal canal; and anterior to the spermatic vessels, 4. The serous tube in the one case, as the serous sac in the other, separates the bowel from contact with the vessels. Moreover, both those kinds of hernia may be regarded as equally liable to constriction, and by the same parts, viz., by the internal ring, D F D, by the conjoined tendon, B, and by the external ring, A*. Therefore, whether the external inguinal hernia be congenital or not, the operation is to be conducted in the same way in reference to the seats of constriction, viz., the inguinal rings.

Fig. 2.—Representing the same condition of parts as in fig. 1, except that the serous spermatic process, E, ("infantile cord,") has degenerated from the tubular form to that of a mere filament in the infundibuliform fascia, D D G, may in the same manner as fig. 1 receive a herniary bowel, and become the sac of this organ. As the tube in this case is pervious in the inguinal canal, D E D A*, and impervious below the external ring, A*, it will not be possible, when it forms a herniary sac, to distinguish this from one originally pouched by the bowel from the closed internal ring, for both would be of the same shape. But this circumstance can be of no moment in regard to the operation required for ordinary external inguinal hernia.

Fig. 3.—When the peritonæum, E, closes the internal ring, D D, while below the closure the serous spermatic tube, F F, remains pervious, then, in order that an external inguinal hernia may occur by dilatation, the bowel must form its sac from the peritonæum at the internal ring. In this case there will exist two serous membranes, viz., the herniary sac and the serous spermatic tube; the former either enclosed in the latter or descended on either side of it. Investing the bowel, therefore, there will appear two serous membranes. But whatever be the anatomical variety in this respect, the points of chief practical importance are not subject to such variation: the relative position of the epigastric and spermatic vessels, the seat of constriction, and the mode of operation, will be the same as in ordinary forms of external inguinal hernia.

Fig. 4.—When, as ordinarily, the internal ring, D D, is closed by the peritonæum, E, and when the bowel dilates this portion of the membrane on the outer side of the epigastric artery, 2, the incipient hernia (sac and bowel) progresses thence, *gradatim*, through the inguinal canal, D D A*, and below this still enclosed in the infundibuliform spermatic fascia, D G. However the sac is formed, whether by the bowel dilatating the inguinal peritonæum, or, after having ruptured this membrane, by dilatating other structures, the sac descending from its original position (where it appears as a shallow pouch), in inverted curved phases, as indicated, assumes the form, position, and dimensions of the place which bounds it in its passage. Within the inguinal canal it is only of the dimensions of this place, and is supported by its parietes. If, while in this place, the bowel suffers constriction, the seat of this must be on the inner side of the internal ring around which the bowel doubles; but the epigastric artery, 2, being here situated, forbids the incision of this part; and then it becomes necessary to slit the inguinal canal on its outer side, from the external to the internal ring, in order to liberate the bowel. When the hernia has passed the external ring, A*, from the time it escapes from that confine till it reaches the testicle, it swells more and more, according to the degree of its descent, A* H H, and necessarily the spermatic membranes, which are now its envelopes, assume its shape. The hernia, now gravitating from the inner border of the internal ring, carries this part and the epigastric artery, 2, 2*, towards the median line; and thus obliterates the obliquity of the canal, while in doing so it changes the seat of constriction from the internal to the external ring. As the hernia now projects from behind directly forwards, its neck is restrained between the border of the conjoined tendon, B, on the inner side, and the opposite border of the external ring. Under those circumstances, it is obvious that, in an operation, the incision should be made through the outer border of the external ring, A*, in the direction of the iliac spinous process, for the epigastric artery, 2*, is immediately behind the conjoined tendon, B, and still on the inner side of the neck of the hernial sac.

Fig. 5.—When the bowel dilates the peritonæum, closing the internal ring, D D, external to the epigastric artery, 2, and forms a sac of that membrane, H H, descending the inguinal canal, D D A*, and within the infundibuliform fibrous tube, D D G, it imitates, in most respects, the original descent of the testicle. The difference between the descents of both organs, arises only from the manner in which they become respectively covered by the serous membrane; for the testicle passes through the inguinal canal behind the process of peritonæum therein contained, and at the same time takes a duplicature of that membrane, which it carries with it to the scrotum; whereas the bowel encounters the inguinal peritonæum point-blank from within the abdomen, and in this way becomes invested by it on all sides.

Fig. 6.—When the bowel pouches the peritonæum from the internal ring outside the epigastric artery, 2, and forms a complete hernia, if afterwards it be reduced, and the internal ring closed, there will exist still an empty hernial sac, F, in the inguinal canal or in the spermatic cord, G. If, again, the bowel dilate the peritonæum from the same place as at first, this second sac, H, will be received by inversion into the one already existing; and thus two sacs, with distinct interiors, will invest the bowel. A series of such occurrences will thus render the inguino-spermatic canal multicapsular, I H F, in respect to the protruding viscus. This condition of parts may occur in any variety of hernia, but much more frequently in the external inguinal, as will be readily understood from the fact of the inguinal canal being originally lined by a serous membrane, owing to the descent of the testicle.

Fig. 7.—The epigastric vessels, 2, being behind the inguinal fascia transversalis, can lend no support to the internal ring, D D, nor to the fibrous tube, D G, prolonged from that membrane. The herniary bowel may therefore dilate the peritonæum, H H, immediately on the *inner* side of the artery, and enter the inguinal canal, in which it will lie oblique and in front of the spermatic vessels, 4, as the external hernia, fig. 5. Both herniæ will become invested by the same structures, not excepting the cremaster muscle. The internal oblique hernia is more liable to be constricted by the edge of the conjoined tendon, B, which is from the first close on its inner side; and that part might (if the case could be known) be safely incised, owing to the absence of the epigastric artery. The testicle, J, is directly below this hernia, as it is in the external variety.

Fig. 8.—The internal oblique hernia, H H, will, owing to the absence at its inner side of the epigastric artery, 2, and the umbilical cord, 3, sooner assume a direct position than the external variety. When either becomes direct, the internal ring, D D, is much widened; but the spermatic vessels, 4, are still to be found behind the sac and the testicle below it. The internal hernia enters the inguinal canal with more facility when the umbilical cord is close to the artery, and both these will then be on its outer side. But when the cord, 3, fig. 7, is apart from the artery, 2, the hernia then enters the canal between them. If the outer part of the conjoined tendon, B, be weak, the hernia may bend it forwards, and will not be constricted by it.

Fig. 9.—The hernia, which enters the inguinal canal, whether internally or externally, to the epigastric artery, must also enter the infundibuliform tube, D D, figs. 5, 7, 8. But the internal hernia, H H, fig. 9, which cleaves the conjoined tendon, B, cannot enter the canal nor the fibrous tube, for that part of the tendon which is outside the neck of the sac prevents that occurrence. In the former cases, the fibrous spermatic tube becomes the fascia propria of the hernia; in the latter case, which from first to last is truly direct, the pubic fascia transversalis furnishes the fascia propria; and hence it is that this hernia has the spermatic vessels, 4, always on its outer side, and the testicle correspondingly pendent. In the operation required for dividing the stricture of this hernia, and for all the others, it will be seen that the external ring may be safely cut in any direction, but the neck of the sac, more deeply situated, can only be safely cut upwards and inwards in the direction of the umbilicus.

direction outwards and upwards, through the intercolumnar fibres which are the chief cause of the constriction, as they determine the area and form of the ring. The border of the ring having been divided on a director, this instrument is to be passed under the aponeurosis in the direction of the inguinal canal; and, taking care that other structures are not included, the aponeurosis is to be slit on the director. This being done, the sac, if not thickened and permanently contracted from the constriction of the external ring, will now expand above it in the inguinal canal, and, the internal ring now permitting, the reduction of the bowel may be effected. If the sac were still contracted into a neck at the situation of the external ring after this was divided, then it would be necessary to open the sac here in order to free the contained bowel. When, after dividing the fibres of the external ring and the aponeurosis, the reduction of the hernia cannot be effected, then the internal ring or the parts surrounding it cause the difficulty. If the lower borders of the internal oblique and transverse muscles feel tense around the internal ring, a few of their fibres are to be divided on a director inserted between them and the neck of the sac, and in doing so the epigastric artery will not be exposed to injury if the incision be made *upwards and outwards*, for that vessel being on the inner side of the internal ring, will be separated from the bistoury by the width of the neck of the hernia. When, after the division of the muscular fibres, the hernia still presents a difficulty to reduction, then the cause of this must be ascribed to the neck of the sac in the embrace of the internal ring, and in this case the sac is to be opened, if it have not been so already. The immediate cause of the constriction will now appear, either as a thickened indurated state of the sac in the girth of the internal ring or else the bowel is adherent to the neck of the sac or to its body or its fundus, thus rendering it impossible to reduce the bowel unless accompanied by the sac itself. If the stricture be caused by the neck of the sac, it of course requires to be divided, and this may be done with safety to the epigastric artery if the incision be made in the direction already named. Adhesions, wherever existing between the bowel and sac, must be severed, if this can be done without injury to the bowel; if not, the sac and bowel are to be reduced together, provided the latter has not the continuity of its canal interrupted, or that the inordinate size of the protrusion does not permit.

The incision through the superficial coverings of an *internal* inguinal hernia requires to be made at a different situation and in a different direction to that for the external form of hernia; and owing chiefly to the situation of the spermatic vessels, and the seat of stricture. For the direct hernia, protruding at once from behind, forwards, through the external ring, the incision should be made vertically along its middle for an inch or so above and below the ring. The skin, adipose tissue and superficial fascia being divided and parted aside, the sac will appear abruptly swelling from the external ring, and clearly indicating that this is a cause of constriction. The fibres of the ring are now to have a director passed under them, and to be divided on that instrument in a direction *upwards and inwards*. When this is done, if the neck of the hernia appears still constricted by the deeper fibrous tissues behind the ring, they are to be divided in the same manner and direction, with a view to avoid the epigastric artery, and then the bowel is to be reduced by manipulating the sac, supposing this to be unopened. The same circumstances, however, which necessitate the opening the sac of an external hernia, as often require this measure for the internal. In the operation for either form of inguinal hernia, the directions of the first and last incisions, as above mentioned, will be found the safest, supposing their anatomical distinction, according to the position of the epigastric artery and spermatic vessels, be clearly ascertainable. But, as we have seen that the positions, oblique and direct, do not always indicate that the epigastric is internal to the hernia of the former character, or external to the hernia of the latter,—for a hernia may enter the inguinal canal on the inner side of the artery, and be oblique, while a hernia originally external to that vessel, and oblique, may, by gravitating inwards, become direct, having still the artery on its inner side; and since, moreover, even if this change of character did not happen in fact, yet the usual deformity of the inguinal parts is enough to render the diagnosis uncertain; it is, therefore, recommended to incise the stricture in either hernia in a line *directly upwards* (Sir Astley Cooper). It will be evident, however, that as the epigastric artery, whatever relation it has to either the oblique or the direct hernia, always inclines towards the median line, so, if the last incision—that through the stricture of the neck of the hernia—be carried *obliquely upwards* in the direction of the umbilicus, it would be much more likely to avoid the vessel through all its varying positions in respect to the neck of the hernial sac.

In this description of the operation for inguinal hernia, it may seem that too little regard was had to the superposition of the several layers of structures as investments of the bowel; but this is in accordance with the small regard in which they are held in the actual operation, and very reasonably so, for, with the exception of the sac itself, there is no necessity for distinguishing between them. Anatomically, their distinction is recognizable, and teaches us the structural condition of the parts in respect to the groin as it is, and the manner in which it is affected by the hernia; but practically their distinction is of no account. In speaking of the sac, the surgeon makes no distinction even between the fascia propria and the serous membrane, for the two, adherent and inseparable, are to him as one in the operation.

Note.—In the above description of the surgical anatomy of the groin, it has been a principal object with me to divest the facts, as much as possible, of the obscuring cloud of nomenclature which surrounds them, as described in the lecture-room and in books, and which still obscures them (so deeply are the unreflecting impressed with names), even when those facts are handled in the dissecting room. On referring to the works of Sir Astley Cooper, Hesselbach, Scarpa, and others, I find attempts made (so it would seem), to establish a distinctiveness between what is called the "intercolumnar fascia" and the "external spermatic fascia," as if these were structures naturally separable from each other, or from the aponeurotic tendon of the external oblique muscle. In these and other works, there is a laboured account of the superficial fascia, as being divisible into two layers; whereupon a considerable difference of opinion has arisen as to whether or not we should regard the deeper layer as being a production of the fascia lata, ascending from the thigh to the abdomen, or rather of that on the abdomen descending to the thigh. Of the same trifling significance, whether surgical or anatomical, and founded on an original error in a too limited view, may be regarded the substance of that contrariety of opinion which prevails as to the true relation which the spermatic cord in the inguinal canal (and consequently the external inguinal hernia) bears to the "lower margins" of the internal oblique, and transverse muscles, and to the cremaster. Albinus, Haller, Camper, Scarpa, and Cloquet, record views, from which it may be gathered that the transversalis and oblique muscles are *penetrated* by the cord, and that this disposition of the parts is (with some exceptions) general. Mr. Guthrie ("Inguinal and Femoral Hernia,") holds the like opinion. Sir Astley Cooper describes the "lower edge" of the transversalis as curved all round the internal ring, and adjacent part of the cord. Now, whilst those statements are equally true to nature, and yet would appear to lead to different conclusions (else why oppose them to one another?), the anatomical point might remain for ever unsettled, did we not, with the philosophic Carus, rise from the tedious consideration of isolated, and hence meaningless particulars, and fuse them into the one comprehensive idea which Cloquet has adopted,—namely, that the cremaster is a *production*—a *part*—of the inguinal muscles, formed mechanically by the testicle, which, in its descent through the inguinal canal, dilates and elongates their fibres before it. In this view, we at once correct the false idea of a "lower margin" of either the transverse or oblique muscle; and with good reason we can credit that the cord is encircled with their fibres, which constitute a cremaster. In like manner, by a too painstaking description, has the simple idea of a tubular production of the fascia transversalis sheathing the spermatic vessels, been dismembered. Of that membrane a pubic and iliac part are spoken of, as if they were distinct; and an internal ring is described as formed between them, as if this ring were an aperture, when it is only the orifice of a tube. This tube itself is differently named in different places: in the "inguinal canal," (which part, in fact, is only a *canal* in so far as the spermatic tube renders it so), it is the "infundibuliform tube;" elsewhere it is the "fascia spermatica interna," or "tunica vaginalis communis," or "tunique fibreuse du cordon spermatique," or "tunica aponeurotica," or "fascia cremasterica." (?) For if the latter name be not applied to it, I know not to what it is, unless, perhaps, it marks some particular one of those small counters—the atomic cellular films connecting the cremasteric fibres—with which the descriptive anatomist, in his play, beguiles his time.

In the same spirit has the dissection of herniæ been conducted, and only to the same result. The coverings of a hernia vary as to number, from the layers of that part of the groin through which it protrudes. This could not occur in the first stages of a hernia, however likely it may be to occur in the latter stages, if the bowel always protruded in slow degrees by dilatation of its envelopes. But that sudden protrusion of the bowel must be attended with rupture of the abdominal membranes, is a matter which, as I have stated in the text, cannot be denied on the score of reason; and upon this only have those of the fullest hospital experience founded their opinions. Mr. Lawrence ("Treatise on Ruptures"), nevertheless, remarks, "When we consider the texture of the peritonæum, and the mode of its connexion to the abdominal parietes, we cannot fancy the possibility of tearing the membrane by any attitude or motion." Cloquet and Scarpa have also expressed themselves to the effect, that the peritonæum always suffers a gradual distension before the protruding bowel. To this opinion, however, that of Sir Astley Cooper is opposed. That great original authority, alluding to the *external* variety of inguinal hernia—which, from the locality in which it occurs, is even more likely to progress by distension of the abdominal membranes than a hernia elsewhere—states ("Lectures on Surgery"), "It is generally thought that the hernial sac is an *elongation* of the peritonæum; but in the oblique inguinal hernia *it is not an elongation*, but only a *real growth of the part*." With regard to the herniary investment termed "*fascia propria*," it is likewise doubtful if that be in all cases a production of the fascia transversalis. The hernia which descends through the inguinal canal must then, we know, be within the infundibuliform fibrous tube, which is a derivation of the fascia; but when the hernia is scrotal and very large, it is scarcely to be expected that the portion of the tube pendent from the external ring can be distinguished after distension and attenuation over so large a surface. Of the internal hernia, which does not enter the inguinal canal, Mr. Lawrence (Op. Cit.) observes—"How often it may be invested by a protrusion of the fascia transversalis, I cannot hitherto determine." Several specimens of this hernia invested by the fascia, have, however, been presented to the museum of St. Bartholomew's Hospital, by Mr. Stanley. Hesselbach writes of the fascia as being always present. Cloquet mentions it as being present always, except in such cases as where, by being ruptured, the sac protrudes through it. Langenbeck states that the fascia is constantly protruded as a covering to this hernia: "Quia hernia inguinalis interna non in canalis abdominalis aperturam internam transit, tunicam vaginalem communem intrare nequit; parietem autem canalis abdominalis internum aponeuroticum, in quo fovea inguinalis interna, et qui ex adverso annulo abdominali est, ante se per annulum trudit." ("Comment. ad Illustr. Herniarum, &c.") If an explanation of those differences of opinion be worth seeking for, it may be had in the following very just remark: "Culter enim semper has partes extricat, quæ involucro adeo inhærent, ut *pro lubitu* musculum (membranam) efformare queas unde magnam illam inter anatomicos discrepantiam ortam" conjicio. ("Icones Herniarum" Camper.)

Fig. 1.

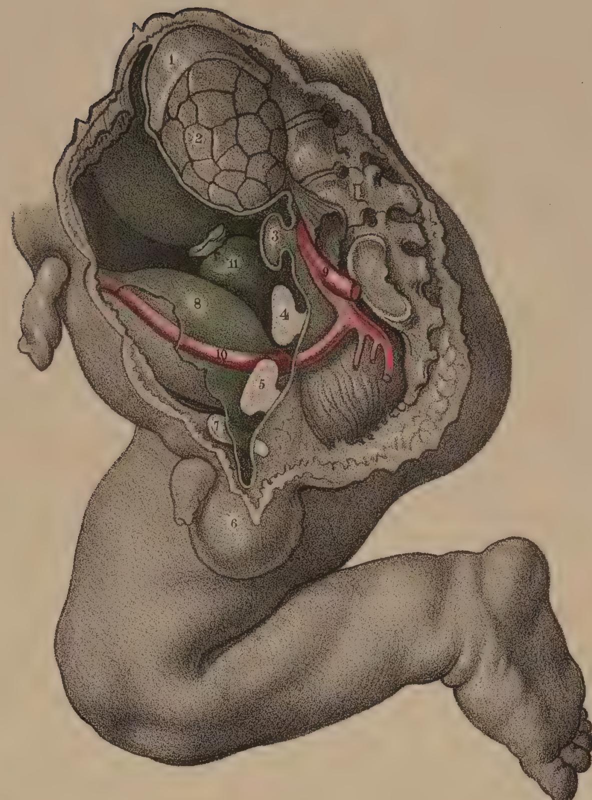


Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

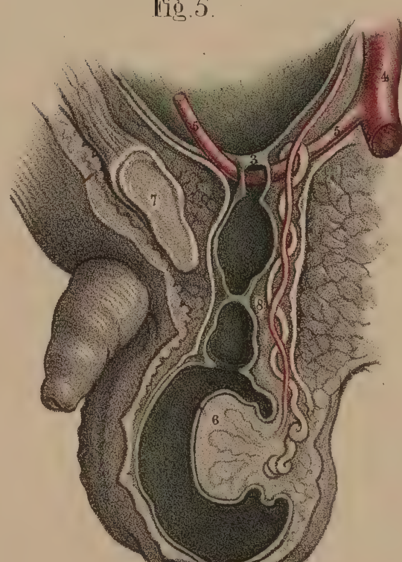


Fig. 6.

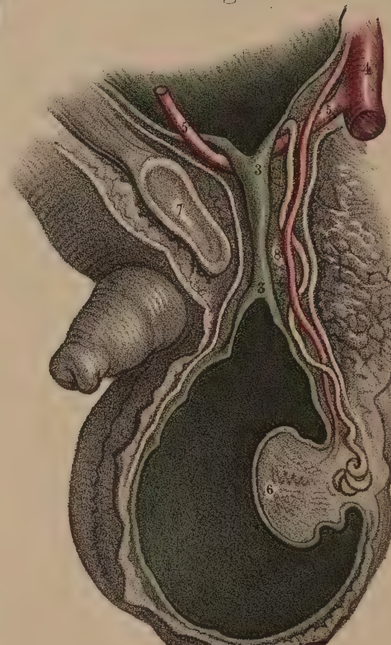
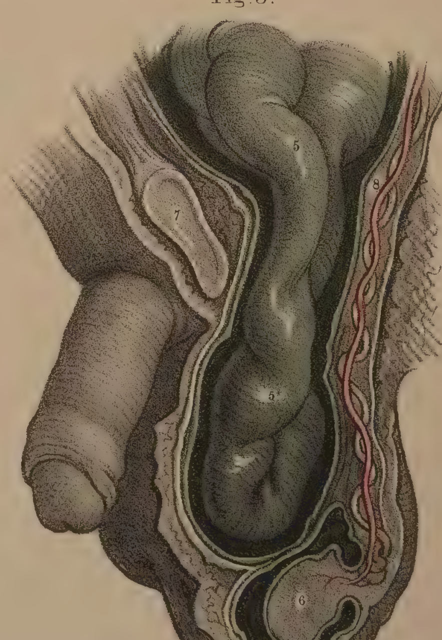


Fig. 7.

Fig. 8.

Fig. 9.



M & N. Hanhart imp.

COMMENTARY ON PLATE XXXIV.

DEMONSTRATIONS OF THE NATURE OF CONGENITAL AND INFANTILE INGUINAL HERNIÆ, AND OF HYDROCELE.

FIGURE 1.—*The descent of the testicle from the loins to the scrotum.*—The fœtal abdomen and scrotum form originally one general cavity, and are composed of parts which are structurally identical. The cutaneous, fascial, muscular, and membranous layers of the abdominal parietes are continued into those of the scrotum. At the fifth month of fœtal life, the testicle, 3, is situated in the loins beneath the lobulated kidney, 2. The testicle is then numbered amongst the abdominal viscera, and, like these, it is developed external to the peritonæal membrane, which forms an envelope for it. At the back and sides of the testicle, where the peritonæum is reflected from it, a small membranous fold or mesentery (mesorchium, *Seiler*) is formed, and between the layers of this the nerves and vessels enter the organ, the nerves being derived from the neighbouring sympathetic ganglia (aortic plexus), while the arteries and veins, springing respectively from the abdominal aorta and vena cava, close to which the kidneys are situated, are correspondingly short. It being predetermined that the testicle, 3, should migrate from the loins, to the scrotum, 6, at a period included between the sixth and ninth month, certain structural changes are at this time already effected for its sure and easy passage. At the time that the testis, 5, is about to enter the internal inguinal ring (seventh or eighth month), a process or pouch of the peritonæal membrane (processus vaginalis) appears descending from this aperture into the scrotum, and the testicle follows it. The descent of the testis is effected by a very slow and gradual process of change. (Tout va par degrès dans la nature, et rien par sauts.—*Bonnet.*) But how, or by what distinct and active structural agent, this descent is effected, or whether there does exist, in fact, any such agent as that which anatomists name "gubernaculum testis," are questions which appear to me by no means settled.* The general lining membrane of the fœtal abdomen is composed of two layers—an outer one (fascia transversalis) of fibrous, and an inner one (peritonæum) of serous structure. Of these two layers, the abdominal viscera form for themselves a double envelope.† The testis in the loins has a covering from both membranes, and is still found to be enclosed by both, even when it has descended to the scrotum. The two coverings of fibro-serous structure which surrounded the testis in the loins become respectively the tunica albuginea and tunica vaginalis when the gland occupies the scrotal cavity. The inguinal canal of the female fœtus lodges, as that of the male, a double invaginated tube of the fibrous and the serous abdominal membranes.

FIGURE 2.—*The testicle in the scrotum.*—When the testicle, 5, descends into the scrotum, 6, which happens in general at the time of birth, the abdomino-scrotal fibro-serous membrane is still continuous at the internal ring, above the os pubis, 7. From this point downwards, to a level with the upper border of the testicle, the canal of communication between the scrotal cavity and the abdomen becomes elongated and somewhat constricted. At this part, the canal itself consists, like the abdominal membrane above and the scrotal membrane below, of a fibrous and serous layer, the latter enclosed within the former. The serous lining of this canal is destined to be obliterated, while the outer fibrous membrane is designed to remain in its primitive condition. When the serous canal contracts and degenerates to the form of a simple cord, it leaves the fibrous canal still continuous above with the fibrous membrane (transversalis fascia) of the abdomen, and below with the fibrous envelope (tunica albuginea) of the testis; and at the adult period, this fibrous canal is known as the internal spermatic sheath, or infundibuliform fascia, enclosing the remains of the serous canal, together with the spermatic vessels. By a similar process the serous inguinal tube of the female fœtus usually becomes obliterated within the fibrous tube as far up as the internal ring. When the serous tube remains pervious to adult age, it is known as the "canal of Nuck," accompanying the uterine ligament.

FIGURE 3.—*The serous tunica vaginalis is separated from the peritonæum.*—When the testicle, 6, has descended to the scrotum, the serous tube or lining of the fibrous tube constituting the inguino-spermatic canal, closes and degenerates into a simple cord, 5, 5, ("infantile spermatic cord,") and thereby the peritonæal sac becomes distinct from its scrotal part, which latter is now the serous tunica vaginalis. But the fibrous tube, or outer envelope, remains still pervious, and continues in this condition throughout life. In the adult we recognise this fibrous tube as the "infundibuliform fascia" of the cord, or as forming the "fascia propria" of an external inguinal hernia. The anterior part of the fibrous spermatic tube descends from the fascia transversalis; the posterior part is continuous with the fascia iliaca, and all three parts with each other. In relation to the testicle, the posterior part of the tube will be seen to be reflected over the body of the gland as the tunica albuginea, while the anterior part blends with the cellular tissue of the front wall of the scrotum. The tunica vaginalis is now traceable as a distinct sac, closed on all sides, and reflected from the fore part of the testicle, above and below, to the posterior aspect of the front wall of the scrotum. This process of metamorphosis is peculiar to the human species.‡

FIGURE 4.—*The abdomino-scrotal serous tube remains continuous and open at the internal ring, and a congenital hydrocele is formed.*—When the serous spermatic tube remains pervious and continuous above with the peritonæum, 3, and below with the tunica vaginalis, the serous fluid of the abdomen will naturally gravitate to the most depending part—viz., the tunica vaginalis; and thus a congenital hydrocele is formed. This kind of hydrocele is named congenital, owing to the circumstance that the natural process of obliteration, by which the peritonæum becomes separated from the tunica vaginalis, has been, from some cause, arrested.§ As long as the canal of communication between the tunica vaginalis and the peritonæum remains pervious, which it may be throughout life, this form of hydrocele is, of course, liable to occur. It may be diagnosed from diseased enlargements of the testicle, by its transparency, its fluctuation, and its smooth uniform fulness and shape, besides its being of less weight than a diseased testis of the same size would be. It may be distinguished from the common form of hydrocele of the isolated tunica vaginalis by the fact that pressure made on the scrotum will cause the fluid to pass freely into the general cavity of the peritonæum. As the fluid distends the tunica vaginalis in front of the testis, 6, this organ will of course lie towards the back of the scrotum, and therefore, if it be found necessary to evacuate the fluid, the puncture may be made

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* Dr. Carpenter ("Principles of Human Physiology") remarks, that "the cause of this descent is not very clear. It can scarcely be due merely, as some have supposed, to the contraction of the gubernaculum, since that does not contain any fibrous structure until after the lowering of the testis has commenced." Dr. Sharpey ("Quain's Anatomy," 5th edition) observes, that "the office of the gubernaculum is yet imperfectly understood." The opinions of these two distinguished physiologists will doubtless be regarded as an impartial estimate of the results of the researches prosecuted in reference to this subject by Haller, Camper, Hunter, Arnaud, Lobstein, Meckel, Paletta, Wrisberg, Vicq d'Azyr, Brugnone, Tumiati, Seiler, Girardi, Cooper, Bell, Weber, Carus, Cloquet, Curling, and others. From my own observations, I am led to believe that no such muscular structure as a gubernaculum exists, and therefore that the descent of the testis is the effect of another cause. Leaving these matters, however, to the consideration of the physiologist, it is sufficient for the surgeon to know that the testis in its transition derives certain coverings from the parietes of the groin, and that a communication is thereby established between the scrotal and abdominal cavities.

† Langenbeck describes the peritonæum as consisting of two layers; one external and fibrous, another internal and serous. By the first, he means, I presume, that membrane of which the transversalis and iliac fasciæ are parts. (See "Comment. de Periton. Structura," &c.)

‡ Mr. Owen states that the Chimpanzee alone, amongst brute animals, has the tunica vaginalis as a distinct sac.

§ The serous spermatic tube remains open in all quadrupeds; but their natural prone position renders them secure against hydrocele or hernial protrusion. It is interesting to notice how in man, and the most anthropomorphous animals, because the erect position would subject these to the frequent accident of hydrocele or hernia, nature causes the serous spermatic tube to close.

with most safety in front of the scrotum. If ascites should form in an adult in whom the tunica vaginalis still communicates with the peritonæal sac, the fluid which accumulates in the latter membrane will also distend the former, and all the collected fluid may be evacuated by tapping the scrotum. When a hydrocele is found to be congenital, it must be at once obvious that to inject irritating fluids into the tunica vaginalis (the radical cure) is inadmissible. In an adult, free from all structural disease, and in whom a congenital hydrocele is occasioned by the gravitation of the ordinary serous secretion of the peritonæum, a cure may be effected by causing the obliteration of the serous spermatic canal by the pressure of a truss. When a congenital hydrocele happens in an infant in whom the testicle, 5, fig. 1, is arrested in the inguinal canal,* if pressure be made on this passage with a view of causing its closure, the testicle will be prevented from descending.

Figure 5.—*The serous spermatic canal closes imperfectly, so as to become sacculated, and thus a hydrocele of the cord is formed.*—After the testicle, 6, has descended to the scrotum, the sides of the serous tube, or lining of the inguinal canal and cord may become adherent at intervals, 3, 8, and the intervening sacs of serous membrane continuing to secrete their proper fluid, will occasion a hydrocele of the cord. This form of hydrocele will differ according to the varieties in the manner of closure; and these may take place in the following modes:—1st, if the serous tube close only at the internal ring, 3, while the lower part of it remains uniformly pervious, and communicating with the tunica vaginalis in front of the testicle, 6, a hydrocele will be formed of a corresponding shape; 2nd, if the tube close at the top of the testicle, 6, thus isolating the tunica vaginalis, while the upper part remains pervious, and the internal ring open, and communicating with the peritonæal sac, a hydrocele of the cord will happen distinct from the tunica vaginalis; or this latter may be, at the same time, distended with fluid, if the disposition of the subject be favourable to the formation of dropsy; 3rd, the serous tube may close at the internal ring, 3, form sacculi along the cord, and close again at the top of the testicle, thus separating the tunica vaginalis from the abdomen, and thereby several isolated hydroceles may be formed. If in this condition of the parts we puncture one of the sacs for the evacuation of its contents, the others, owing to their separation, will remain distended.† The female inguinal canal may become the seat of hydrocele if the canal of Nuck exists.

Figure 6.—*Hydrocele of the isolated tunica vaginalis.*—When the serous spermatic tube, 3, 3, becomes obliterated, according to the normal rule, after the descent of the testicle, the tunica vaginalis in front of the testicle, 6, is then a distinct serous sac. If a hydrocele form in this sac, it may be distinguished from the congenital variety by its remaining undiminished in bulk when the subject assumes the horizontal position, or when pressure is made on the tumour, for its contents cannot now be forced into the abdomen. The testicle, 6, holds the same position in this as it does in the congenital hydrocele ‡ The radical cure may be performed here without endangering the peritonæal sac. Congenital hydrocele, as it involves the spermatic cord as far upwards as the internal ring, is of a cylindrical shape; and this is mentioned as distinguishing it from isolated hydrocele of the tunica vaginalis, which is pyriform; but this mark will fail when the cord is at the same time distended, as it may be, in the latter form of the complaint, in which the separation between the peritonæum and tunica vaginalis has been effected only at the internal ring.

Figure 7.—*The serous spermatic tube remaining pervious, a congenital hernia is formed.*—When the testicle, 6, has descended to the scrotum, if the canal of communication between the peritonæum and the tunica vaginalis be not obliterated, a fold of the intestine, 5, 5*, will follow the testicle, and occupy the cavity of the tunica vaginalis. In this form of hernia (hernia tunicæ vaginalis, *Cooper*), the intestine is in front of, and in immediate contact with, the testicle. The intestine, in this case, may descend lower than the testicle, and envelope this organ so completely as to render its position very obscure to the touch; but the spermatic vessels are always behind the herniary bowel. This form of hernia is named congenital, since it occurs in the same condition of the parts as is found in congenital hydrocele—viz., the internal inguinal ring remaining unclosed, and the serous spermatic tube pervious throughout. It may occur at any period of life, so long as the original congenital defect remains. In the female the canal of Nuck receiving a hernia would render this truly congenital, but the sac could not be distinguished from the ordinary one. It may be distinguished from hydrocele by its want of transparency and fluctuation. The impulse which is communicated to the hand applied to the scrotum of a person affected with scrotal hernia, when he is made to cough, is also felt in the case of congenital hydrocele. But in hydrocele of the separate tunica vaginalis, such impulse is not perceived. Congenital hernia and hydrocele may co-exist; and, in this case, the diagnostic signs which are proper to each, when occurring separately, will be so mingled as to render the precise nature of the case obscure. A hernia may be truly congenital, and yet the bowel may not have entered the tunica vaginalis. Thus, if the serous spermatic canal be obliterated only at the top of the testicle, the bowel, which enters the open internal ring and descends through the cord, cannot proceed further than the point of obliteration. Congenital hernia must be of the external oblique variety, because the open end of the serous spermatic tube is invariably external to the epigastric artery.

Figure 8.—*Infantile hernia.*—When the serous spermatic tube becomes merely closed, or obliterated at the internal inguinal ring, 9, the lower part of it is pervious, and communicating with the tunica vaginalis. In consequence of the closure of the tube at the internal ring, if a hernia now occur, it cannot enter the tunica vaginalis, and come into actual contact with the testicle, 6. The bowel, 5, 5*, therefore, when about to force the peritonæum, 8, 8, near the closed ring, 9, takes a distinct sac or investment from this membrane. This hernial sac will vary as to its position in regard to the tunica vaginalis, according to the point whereat it dilates the peritonæum at the ring. The peculiarity of this hernia, as distinguished from the congenital form, is owing to the scrotum containing two sacs,—the tunica vaginalis and the proper sac of the hernia; whereas, in the congenital variety, the tunica vaginalis itself becomes the hernial sac by a direct reception of the naked intestine. If in infantile hernia a hydrocele should form in the tunica vaginalis, the fluid will also distend the pervious serous spermatic tube, as far up as the closed internal ring, 9, and will thus invest and obscure the descending herniary sac, 8, 8, 5. This form of hernia is named "infantile" (*Hey*), owing to the congenital defect in that process, whereby the serous tube lining the cord is normally obliterated. Such a form of hernia may occur at the adult age for the first time, but it is still the consequence of original default.

Figure 9.—*Oblique inguinal hernia in the adult.*—This variety of hernia occurs not in consequence of any congenital defect, except inasmuch as the natural weakness of the inguinal wall opposite the internal ring may be attributed to that cause. The serous spermatic tube has been normally obliterated for its whole length between the internal ring and the tunica vaginalis; but the fibrous tube, or spermatic fascia is open at the internal ring, where it joins the transversalis fascia, and remains pervious as far down as the testicle. The intestine, 5, 5*, forces and distends the upper end of the closed serous tube; and as this is now wholly obliterated, the herniary sac, derived anew from the inguinal peritonæum, enters the fibrous tube or sheath of the cord, and descends it as far as the tunica vaginalis around the testicle, 6, but does not enter this sac, as it is already closed. When we compare this hernia, fig. 9, with the infantile variety, fig. 8, we find that they agree in so far as the intestinal sac is distinct from the tunica vaginalis; whereas the difference between them is caused by the fact of the serous cord remaining in part pervious in the infantile hernia; and on comparing fig. 9 with the congenital variety, fig. 7, we see that the intestine has acquired a new sac in the former, whereas, in the latter, the intestine has entered the tunica vaginalis. The variable position of the spermatic vessels and the testicle in figs. 7, 8, and 9, is owing to the difference in the anatomical circumstances under which these herniæ have happened.

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* In many quadrupeds (the Rodentia and Monotremes) the testes remain within the abdomen. In the Elephant, the testes always occupy their original position beneath the kidneys, in the loins. Human adults are occasionally found to be "testiconde;" the testes being situated below the kidneys, or at some part between this position and the internal inguinal ring. Sometimes only one of the testes descends to the scrotum. Are we to infer from those cases an original debility or an absence of a "gubernaculum?" Could the testis, when appearing (as I have seen it) subcutaneously at the perinæum, have been brought there by a gubernaculum, whose action—supposing it to exist—tends only to the scrotum?

† According to M. Cloquet and Mr. Lawrence, most of the serous cysts found around inguinal hernial tumours are ancient hernial sacs which, after successive reductions of the bowel and closures of their necks, have remained and become adherent to the hernia last formed.

‡ When a hydrocele is interposed between the eye and a strong light, the testis appears as an opaque body at the back of the tunica vaginalis. But this position of the organ is, from several causes, liable to vary. The testis may have become morbidly adherent to the front wall of the serous sac, in which case the hydrocele will distend the sac laterally. Or the testis may be so transposed in the scrotum, that, whilst the gland occupies its front part, the distended tunica vaginalis is turned behind. The tunica vaginalis, like the serous spermatic tube, may, in consequence of inflammatory fibrinous effusion, become sacculated-multilocular, in which case, if a hydrocele form, the position of the testis will vary accordingly.—See Sir Astley Cooper's work, ("Anatomy and Diseases of the Testis;") Morton's "Surgical Anatomy;" Mr. Curling's "Treatise on Diseases of the Testis;" and also his article "Testicle," (Cyclop. Anat. & Physio.)

Fig. 2.

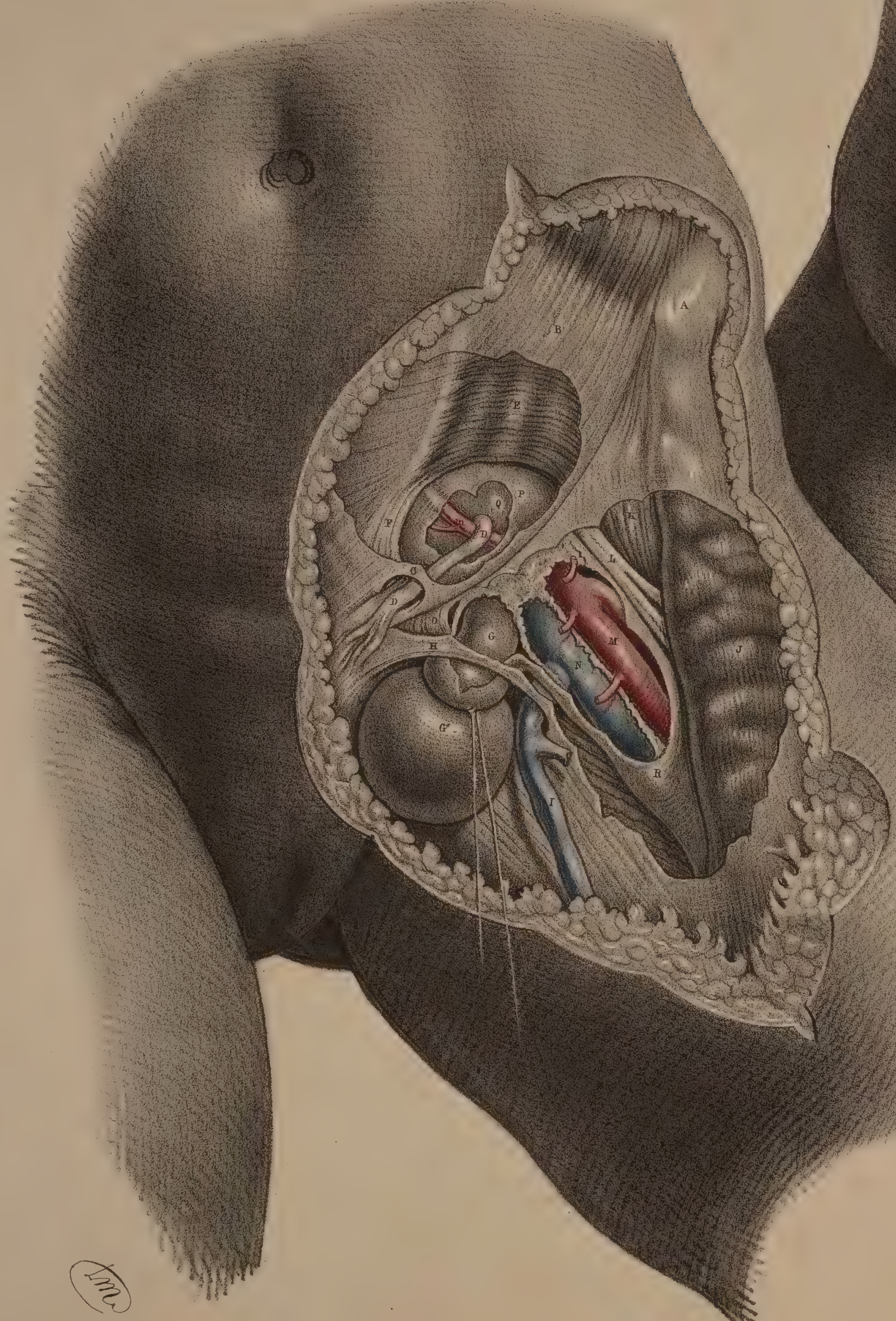
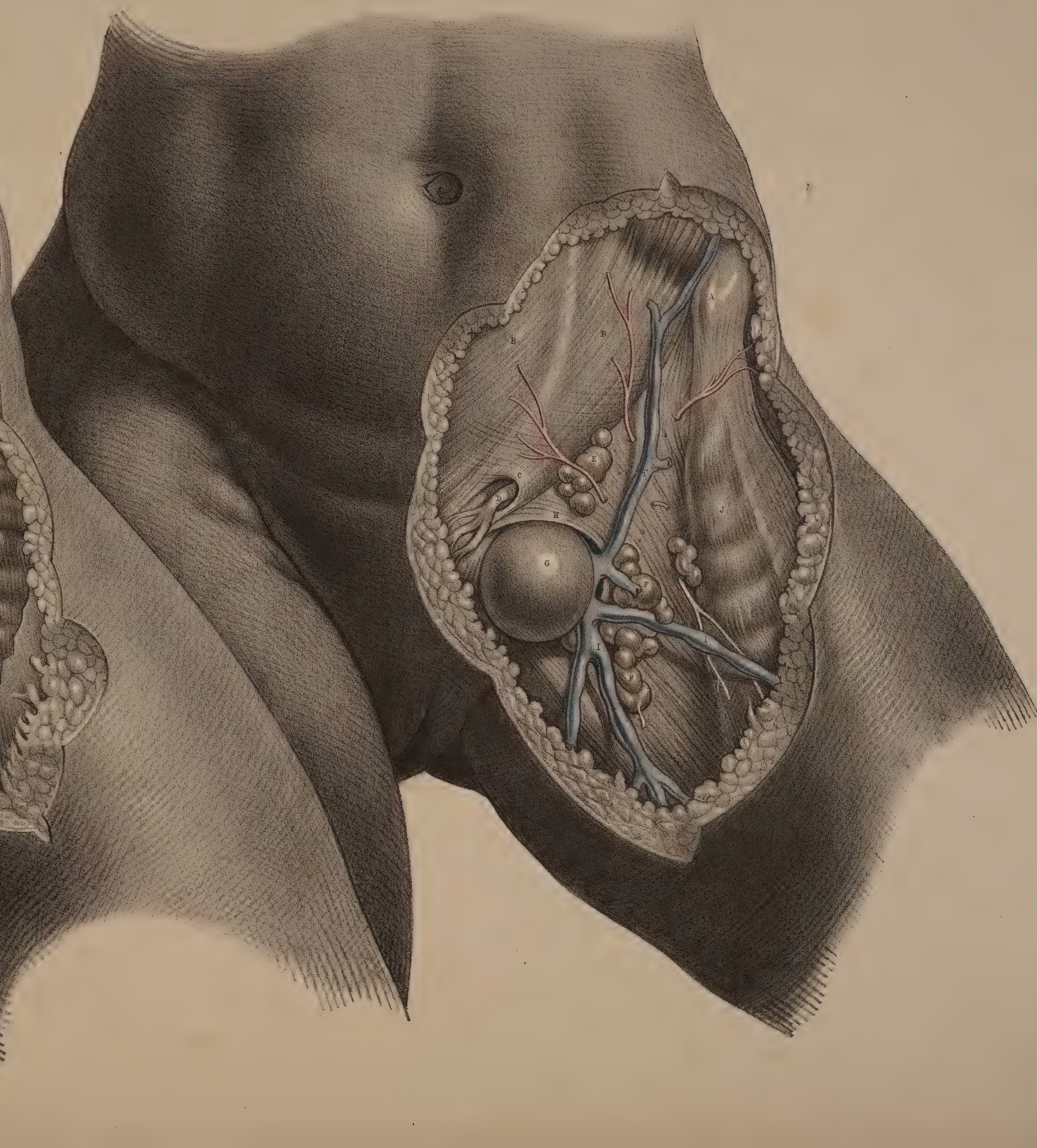


Fig. 1.



COMMENTARY ON PLATES XXXV. XXXVI. XXXVII. & XXXVIII.

FEMORAL HERNIA. ITS ANATOMICAL VARIETIES. THEIR DIAGNOSIS. THE SEAT OF STRICTURE. THE TAXIS. THE OPERATION. UMBILICAL HERNIA, &c.

The femoral hernia originates, progresses, and takes its investments in the same manner as an inguinal hernia. The ordinary situation at which the femoral hernia arises, viz., the femoral ("crural") ring, immediately on the inner side of the iliac vein, where this vessel is about to pass to the thigh, is so close below and between the inguinal rings, that the same portion of the bowel covers them, and would, under the same line of abdominal pressure, if the three rings were equally passable, become herniary at the same time through the three. That this does not occur more frequently than it does, and that there is a place of election for the bowel to protrude at, must then be altogether due to a more completely defensive character of the parts at one situation than at another. But for this, the femoral hernia would be as common in the male as it is in the female, and the inguinal hernia as liable to happen in the female as in the male. The opposite to this statement is known to be the case, and the explanation of it is purely anatomical: the male inguinal region is rendered somewhat less compact as to its parts, in giving transmission to the spermatic vessels, after the descent of the testicle, than the female inguinal region, which transmits only the uterine ligament; and, moreover, the width of the female pelvis, measured from the symphysis pubis to the iliac spinous process, is greater than that of the male, and the parts which pass to the thigh, beneath Poupart's ligament, in the former sex, are less closely bound together, whereby, especially the triangular interval, bounded by the vein outside, by Poupart's ligament above, and by the horizontal ramus of the os pubis below, is rendered of wider area than in the male, at the same time that it has only its ordinary defence, viz., the peritonæum and subserous tissue, against intestinal protrusion. But this different disposition of the parts in the corresponding regions of both sexes, which favours the occurrence of femoral hernia more frequently in the female, and of inguinal hernia in the male, does not always obtain; and hence it is that the same variety of the disease may be induced in both sexes, and at all ages, indiscriminately. If the texture of the structures forming the inguinal canal of the female, be from any cause attenuated, and the inguinal rings looser than natural, if the obliquity of the canal be not fairly established, or if, from congenital defect, the process of peritonæum (canal of Nuck) which accompanies the uterine ligament remains pervious, and open at the internal ring, where it will be continuous with the peritonæum, then a hernia will sooner form in this situation than at the femoral ring, if this latter be contracted by an unusually broad insertion of Poupart's ligament into the pectineal ridge. If, on the other hand, the inguinal canal of the male be set, as ordinarily it is, well—obliquely, with its walls firm and its rings small, and if, at the same time, the femoral ring be wider than usual, owing to the pectineal portion of Poupart's ligament being narrow, and owing also to an outward yielding of the femoral vessels and their sheath, which a wasted condition of the psoas and iliacus muscles may permit, then a hernia will more readily occur at this situation than at the inguinal rings. When circumstances are equally favourable to the formation of hernia at the groin and at the thigh, both varieties will then coexist, whether the subject be male or female. It seems, therefore, to be in consequence of a weakened condition of the parts in any situation, that a hernia should there occur; but besides this, we recognize other causes, combining to render its occurrence at the inguino-femoral region more frequent than elsewhere. The inguinal pouches are recesses for the reception of the bowel, and thereby concentrate to themselves the visceral pressure from above. The femoral ring is immediately under those pouches, and is itself in a recess formed between Poupart's ligament above, and the os pubis below, and having the iliac vessels and their epigastric branches on its outer and upper border, and the umbilical ligament generally on its inner side, where this cord raises the peritonæum in a fold. From this it will be seen that the herniæ, designated *femoral* and *inguinal*, have, in respect to the necks of their sacs, little more than a nominal difference as to place, for they are divided only by the epigastric vessels; and the very small interval which those vessels mark is not much increased by Poupart's ligament, for they are behind this structure. In illustration of this close proximity between the crural and inguinal rings, I would venture the following remark, as anatomically correct in the majority of cases: if around a point on Poupart's ligament, about an inch external to the pubic spine, a circle of an inch in diameter were described, that circle would cut a portion from each of the adjacent sides of the three rings, and divide the spermatic vessels in the inguinal canal, and the epigastric vessels at its internal ring. A circle of a few lines more in diameter, drawn around the same point, would touch, by the outer part of its periphery, the femoral vein. With these observations in memory, we may pass to the separate description of femoral hernia, without any likelihood of losing in the name "*femoral*," the important idea that that protrusion is, as to its original seat, as truly inguinal as that which appears through the external ring, and requires no less caution to avoid the epigastric artery in an operation, at the same time that it always holds an additional close relation to a vessel of much greater magnitude—the femoral vein, and occasionally to the obturator artery arising from the epigastric.

The structure which is known as Poupart's ligament, in connexion with the inguinal forms of herniæ, which escape from the abdomen immediately above it, is named the femoral, or crural arch, in relation to the femoral hernia, which passes from the abdomen immediately below it, The simple line, therefore, described by this ligament, explains the narrow interval at which both varieties of the complaint are separated at their origins. The inner portion of the ligament being disposed horizontally as to its breadth, when the body stands erect, isolates the inguinal from the femoral region in such wise, that (so to express the idea) it presents the character of an arch which at the same time supports an aqueduct—the inguinal canal, and spans a road—the femoral sheath. Extending between the iliac and pubic spinous processes, and being connected with the inguinal aponeurosis and the fascia lata, the femoral arch appears as a distinct part only when those membranes are separated from it, but still, by its posterior surface it is connected with the fascia transversalis, and the peritonæum, and these membranes are reflected from it to the iliac fossa, and down into the pelvis. When the fascia lata is separated from the femoral arch between its two extremes, the parts which pass beneath it, from the abdomen to the thigh, will be seen to occupy nearly the whole of that space which the upright anterior margin of the iliac bone bounds externally, the horizontal ramus of the pubic bone inferiorly, and the femoral arch itself superiorly. That space is irregularly triangular: the upper outer angle, formed by the union of the arch with the iliac spinous process, is acute; the lower outer angle, formed by the junction of the iliac and pubic bones, is obtuse, and rendered so by the curved roof of the acetabulum; the inner angle, formed by the union of the arch and pubic bone at the pubic spine, is acute, and is occupied by that process of the arch (Gimbernat's ligament)

FIGURES OF PLATE XXXV.

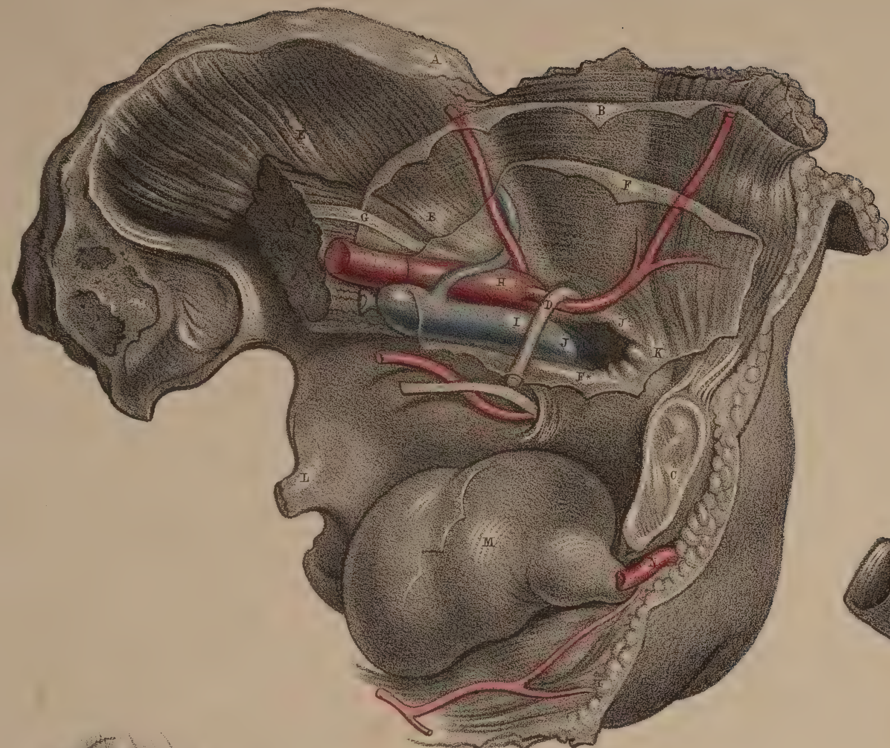
Fig. 1.—Femoral hernia in the female.—A, Anterior iliac spinous process.—B B, Aponeurosis of external oblique muscle.—C, External inguinal ring.—D, Uterine ligament.—E, Inguinal lymphatic bodies.—F F, Femoral lymphatic bodies.—G, Hernial sac.—H, Falciform process.—I, Saphena vein; i, anterior superficial femoral branch; i*, external circumflex iliac vein.

Fig. 2.—A view of the deeper structures of fig. 1.—Other parts, marked as in fig. 1.—E, Internal oblique muscle.—F, Conjoined tendon.—J, Sartorius muscle.—K, Iliacus muscle.—L, Anterior crural nerve.—M, Femoral artery.—N, Femoral vein.—O, Gimbernat's ligament on the inner side of the neck of—G, The hernia in the Femoral canal.—P, Transversalis fascia.—Q, Peritonæum closing internal inguinal ring.—R, Sheath of Femoral vessels.

which, with the conjoined tendon, is attached to the pectineal ridge. Through the middle of this space (which the artery marks) the femoral vessels in their sheath issue from the abdomen, and are borne forwards by the rising roof of the acetabulum, and by the intervening part of the psoas muscle. The artery divides this space into two of about equal areas. Of these, the external one is completely occupied by the psoas and iliacus muscles passing to their insertions into the lesser trochanter of the femur ; and the anterior crural nerve appears close to the outer side of the artery. The space internal to the artery transmits the femoral vein only; and as this vessel lies close to the artery, the interval (when there exists one) between the vein and the outer margin of Gimbernat's ligament may be said to be unoccupied and free for a herniary passage of the bowel, but for the peritonæum, which, by being drawn across it, occludes it. Now, although an interval may occur between the vein and the margin of Gimbernat's ligament, there is never an interval between this part and the inner side of the femoral sheath; for the fascia transversalis, of which the sheath is formed, always protrudes in close contact with the ligament. The interval, therefore, between the vein and the ligament must, in regard to the fibrous membrane, always be the orifice (femoral ring) of a duct (femoral canal), and the width of both must be determined by the ligament, for the vein ever holds its normal position. It is this circumstance which, in connexion with the femoral hernia transmitted through the ring, has made Gimbernat's ligament so much an object of note, but more so, in fact, than (separately taken) it should be. It is described as always being the particular seat of stricture, although it is a part which has a common insertion with the conjoined tendon, and the two are so blended together, that while it is with difficulty they can be separated in dissection, it may well be doubted if the two are not at the same time divided in the operation; for both, in many instances, have insertions of equal breadth, and when the case is otherwise, then that which projects the more laterally—and the one does so, perhaps, as often as the other—becomes the principal object of incision. Gimbernat's ligament, therefore, requires its situation and form to be known, forasmuch, also, as in relation to it we may notice what other parts are as likely as itself to cause constriction. It is deeply situated, and its outer free margin more so than its inner part, for the pectineal ridge into which it is inserted is directed obliquely backwards and outwards from the pubic spinous process, which may be felt subcutaneously. It has the upper cornu of the falciform process in front, and the conjoined tendon behind. Its shape is acutely triangular, corresponding to the form of the space it occupies between the inner end of the femoral arch above, and the pubic bone below. Its apex is internal at the pubic spine; its base is external, sharp, and concave, and in apposition with the inner compartment (femoral canal) of the sheath of the vessels. It measures an inch, more or less, in width, and less than half an inch in height; for it is turned slantingly towards the abdomen, owing to the femoral arch being on a plane anterior to the pectineal ridge. It is broader in the male than in the female—a fact which is said to account fully for the greater frequency of femoral hernia in the latter sex than in the former (Monro). But as this condition of the part is only relative, it is clear that the effect does not answer to that cause alone; for if the ligament in the male is broader, so likewise in the female is the space which intervenes between it and the femoral vein, by reason of the greater length of the pubic bone. To the latter fact, therefore, may the effect be more reasonably ascribed; for while the female os pubis is always longer than that of the male, the breadth of the ligament is as liable to vary in the one sex as in the other. In this description of the parts concerned in femoral hernia, added to that already given, I know of no omission except that structure which anatomists have named the *deep femoral arch*, and which, when it is distinguishable, appears as a band of fibrous substance, spanning the femoral sheath more closely than does the superficial arch. When present, it would, by its position, serve to prevent the formation of a hernia, by supporting the neck of the femoral sheath, in close apposition with the vessels externally, anteriorly, and internally; in which latter position it unites itself with the conjoined tendon behind Gimbernat's ligament, and thus with them combines, as well to determine the form and area of the ring, as to constrict the hernia.

As, in respect to its cause, and the manner of its formation, a femoral hernia does not differ from an inguinal hernia, the same general remarks which have been made in a former place, illustrating that subject, would, if true, apply to both varieties of the complaint. It seemed to me not unreasonable to doubt that the sac of a fully-formed inguinal hernia was a production in actual substance of that small portion of the peritonæum which the viscus at first pouched; and that doubt even more strongly suggests itself in regard to the sac of a femoral hernia protruding through the femoral ring. This place is seldom, even in the female, of greater diameter than half an inch, even when it transmits a hernia of the largest size. It is girt all round by dense, unyielding structure; its upper and inner arcs are formed by the superficial and deep femoral arches, and the dense fibrous bands of the conjoined tendon and Gimbernat's ligament; its outer arc is formed by that septum of the femoral sheath which isolates the vein from the femoral canal; and inferiorly, the fibrous membrane is supported on the pubic bone. With the femoral ring so formed, and of so small an area, which no protruding force can possibly render larger than it is naturally, it may indeed well remain a question whether or not the sac which emerges through the saphenous opening, of a size equal to that of a closed adult hand, be the result of a gradual dilatation of that part of the peritonæum which at first occluded the ring. To those who could see cause for believing this, inasmuch as the intestine itself is the same organ after its hernia as before, I would answer that there is no analogy upon which to found that reasoning. The intestine is free-moving within the abdomen, and so loosely suspended by its mesentery, that through a wound of the abdominal parietes it would suddenly protrude at the fullest herniary length; but how should the peritonæum, laid as it is, evenly, and closely attached to the inguinal parietes, undergo a dilatation, whether quick or slow, to the same degree, without rupture; especially through the femoral ring, whose salient edges are sufficiently sharp and resistant to cut that membrane, under ordinary pressure? If the intestine enter the femoral canal by sudden pressure from above, it may be taken for granted that it could not have done so except by a rupture of the peritonæum. And as we know that a hernia here occurring is more frequently than otherwise the effect of sudden efforts of the body, from which we may infer a rupture of the membrane; and while we also find that in whatever manner this hernia be formed, a serous sac is the immediate envelope of the bowel, such sac must, in many instances at least, be a secondary formation, even when it is of no greater volume, and has advanced no farther, than the femoral canal which contains it. What is true, then, of its first stage, must be true of all its future stages; for whether the bowel in the first instance rupture the peritonæum, or, after forming for itself a primitive sac, wear through this, then the bowel will leave this membrane behind it in the canal, and will progress, devoid of a sac, if it does not furnish for itself one, by an assimilation to its own serous surface, of those tissues which are opposed to it. This it is quite possible for the bowel to effect, so slow are the degrees of its advancement. The aphorism, "*Natura non facit saltus,*" is applicable to the development of a hernia, when once entered into the canal; and hence it is that we cannot clearly distinguish between the facts of a bowel protruding the serous membrane from its original seat, and forming that membrane in the degree of its own progress. But as a matter of reasoning the latter mode would appear to be the true one; for the quantitive difference between the sac of a bubonocele and a scrotal hernia, shows the impossibility of fashioning the greater from the less; for though the one of greater volume may be distended from the lesser one, the former must exhibit an attenuation of its structure corresponding to the degree of its distension; and at the same time that the physical character of the peritonæum is such as not to admit of that kind of increase, we know that with its enlargement of volume the sac does *not* undergo a thinning in substance, but oftentimes such an increase, as to be nearly half an inch in thickness. In the anatomical and the pathological condition of the parts, I observe the facts to be confirmatory of the present views. Judging from the physical characters of the parts in which the internal inguinal and the femoral rings are formed, it certainly would appear that a sac may at first be produced by dilatation of the peritonæum at the former place, by reason of the parts there being more yielding than at the femoral ring. But admitting that a primitive inguinal sac has every appearance of being the result of force, originating within the abdomen, it appears to me, on inspecting the state of a large scrotal hernia and its contents, that its volume is due more to the traction of the gravitating herniary parts, than to abdominal impellent force, the one force having been succeeded by the other at a point, in time, probably, when the hernia became pendent from the external abdominal ring. In this case the peritonæum appears as dragged out after the bowel, but to such extent only as the increasing area of the internal ring admits. When the cœcum or the bladder forms the contents of such a hernia, those viscera are denuded of their partial serous envelopes, still more than they were while at their proper seats within the abdomen, and proving that the peritonæum has not that capability for extension which some suppose it to have. That the peritonæum furnishes for the sac, however large this be, no greater portion of itself than that which would equal the area of the herniary opening, there is

Fig 2.



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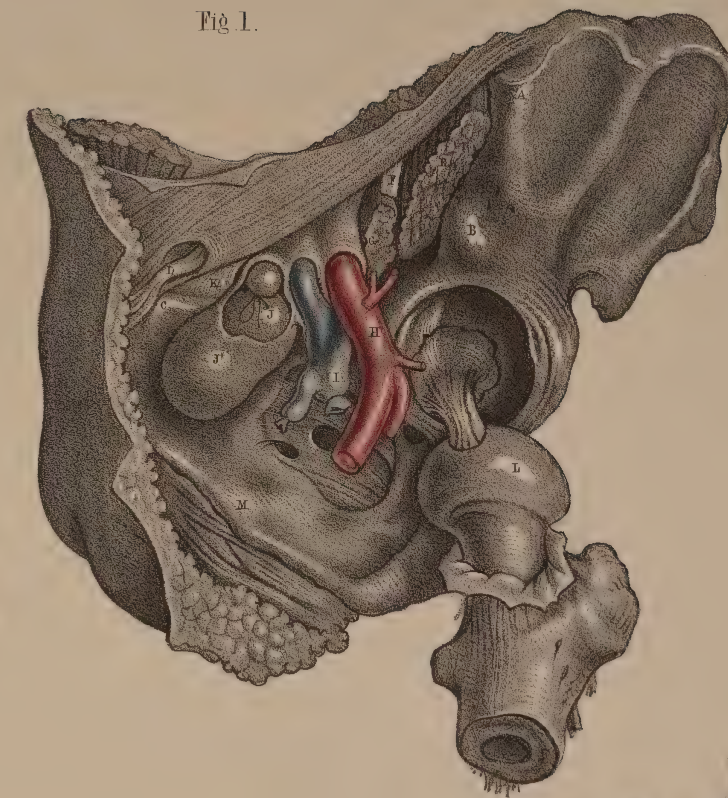

Fig. 3.

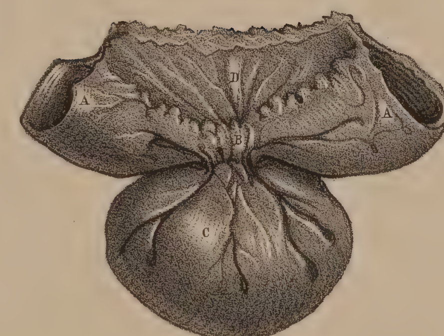

Fig. 4.

Fig. 5.

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direct anatomical evidence: a hernia, whether of the inguinal or femoral kind, which protrudes between the epigastric artery and the umbilical cord, leaves those adherent to the inguinal wall still in the same position as they normally occupy, which could not be the case if a greater breadth of the membrane were protruded, for they would protrude with it, and be found in the herniary canal attached to the sac. This never occurs, and therefore they are as marks of that small extent of the membrane which has protruded. Let those, then, who would uphold the doctrine that a sac must be a production of the peritonæum, reconcile to themselves, if they reasonably can, the idea that *a sac pendent to the knees* is an extension of that part only of the peritonæum which is limited by the epigastric artery externally, and by the umbilical cord internally.

Of the femoral hernia, several varieties have been seen, and, like those of the inguinal hernia, they may be named according to their respective situations. In relation to the femoral vessels, the hernia has been found *anterior*, *posterior*, *external*, and *internal*. The latter is by far the most common situation, so much so, that the name "*femoral*" hernia usually implies a protrusion into the femoral canal, through the femoral ring. Of the three former varieties, a brief anatomical notice will be therefore sufficient. The mode in which the femoral sheath is produced from the transversalis fascia, and becomes simply applied to the sides of the vessels, renders it of course not impossible for a hernia to enter the sheath at any point around its neck; for there is nothing to defend this part but the peritonæum, reflected from the inguinal parietes to the vessels. Instances of femoral hernia, external to the vessels, have been observed by M. Cloquet, Hesselbach, and others. The former anatomist has seen a hernia descend the sheath *once* in front of, and *once* behind the vessels. I have seen an example of the external hernia in which the cœcum protruded, and another in which the sigmoid flexure of the colon was the herniary viscus—the former having been only partially covered by a sac, the latter entirely enclosed in one. Hey, Sir Astley Cooper, and Scarpa, have never seen the external hernia, and this must be good proof of its rarity. The causes of this circumstance are physiological and anatomical, and accord with the views I have enunciated regarding the mechanism of the trunk of the body as affecting its viscera. The muscular roof of the abdomen, acting upon the viscera with vertical pressure, and the muscular sides and front of it acting at the same time with lateral pressure, combine, in the upright posture of the body, to concentrate all the lines of force towards the pelvic organs, through the medium of the elastic bowels. This is the effect of their action, whether for the purpose of voiding the pelvic organs or not. The force so directed is diverted from the iliac regions external to the femoral vessels, and takes effect on the inguinal regions, in which the femoral ring, the ordinary seat of femoral hernia, is situated. The form of the abdomen contributes to concentre the force originated in its muscular walls. The ilio-inguinal fossa, of which the iliacus muscle is the posterior boundary, and the transversalis muscle the anterior, is terminated below by their meeting at a line corresponding with Poupart's ligament; and this line is so inclined from the iliac spinous process, externally and above, to the pubic symphysis, internally and below, that the moveable viscera under pressure slide towards the median hypogastric region. Whilst the pressure is thus borne from the ilio-inguinal fossa in all efforts, it must be as a consequence alone of the laxity of the parts where the femoral vessels are transmitted, that a hernia can occur outside, in front of, or behind them; for in the natural healthy state of those parts, their union is such, that no ordinary force could sunder them; and this union is very much owing to the manner in which the femoral arches are bound down by the intermuscular septa outside the femoral sheath, and by the intervascular septa within it. When a femoral hernia has taken place on the right side, before, behind, or outside the femoral vessels, the existence and the form of its sac will depend on the organ protruding. The cœcum, when situated low in the iliac fossa, and but partially invested by the peritonæum, and without a mesentery, may protrude from behind that membrane, and passing out below the femoral arch, will denude itself still more of its serous covering, and present its cellular coat externally; while, if it have any form of sac, this will cover it only anteriorly in some degree, and appear as drawn out after (not pushed before) the viscus. Such appearance cannot, I believe, ever be presented by the sigmoid flexure of the colon; for this part, though having but a short mesentery, still hangs so free against the femoral arch, that it opposes the parietal peritonæum, and if it does not rupture that membrane, cannot protrude, except by dilating it in the form of a complete enclosing sac. Such was the appearance of the sac about the hernia of this viscus which I have seen. For the same reasons—viz., their free pendency, and their opposing the parietal peritonæum, neither the small intestine nor the omentum can protrude about the femoral vessels, unless invested by a sac, if they have not ruptured the membrane. In all those cases, a fascia propria, derived either from the fascia transversalis, or from the sheath of the vessels, will be found as a covering, if that membrane have not been ruptured. When we consider the dense unyielding nature of the iliac part of the fascia lata, beneath which any one of those hernia must necessarily be situated, its obstruction from permanent compression will be readily conceived; but the effects of this are in a great measure obviated by the very wide necks which those herniæ usually have, in consequence of the weakness of the parts transmitting them; for if this weakness did not previously exist, the herniæ could not have occurred. The anatomical relations of those herniæ are easily to be learned. If the bowel protrude beneath the femoral arch, anterior to the vessels, its sac will necessarily lie in contact with them, for their sheath will form its fascia propria. When the hernia takes place external to the vessels, it may also enter the sheath; but if the fibres of the deep femoral arch be strong enough to prevent its doing so, then the fascia transversalis, like the peritonæum, becomes protruded before the bowel. In this hernia the circumflex iliac artery will be either in front of, or behind, the neck of the sac, according as that vessel is situated high or low, in respect to the superficial femoral arch: the anterior crural nerve must always be behind this hernia, for the nerve issues on the thigh from under the psoas muscle. When the hernia is behind the femoral vessels, it must be within their sheath, on account of the point from which it has burrowed beneath them being within the abdomen, corresponding with the place where the vessels make their exit.

The hernia which takes place internally to the femoral vessels is owing to these causes—viz., the concentration of the force which compresses the bowel to this particular locality; the horizontal position and the width of the femoral ring, which is but fenced by the peritonæum and the subserous membrane. As the course to be taken by the viscus, when this hernia is being formed, is through the femoral ring and canal, the structures which have already been noticed as bounding this passage, will of course hold the like relation to the neck of the hernia. The manner in which this hernia is formed and takes its investments in its descent, may be briefly stated thus:—The bowel, if the peritonæum at first resist rupture, dilates that membrane where it closes the femoral ring, and pushes it before itself into the canal. This covering is the hernial sac. In addition to the sac, the crural septum, which is but the subserous tissue crossing the ring, has at the same time entered the canal as the second investment of the bowel. The hernia is now enclosed in the canal, the sheath of which forms its fascia propria. The area of its neck is determined by that of the ring, and the volume of it is limited to that of the canal. In this stage the hernia is so small and so bound down by the iliac part of the fascia lata, which covers it by the falciform border, that it cannot be distinguished on the superficies, as it forms no

FIGURES OF PLATE XXXVI.

Fig. 1.—Femoral hernia in the Female.—A B, Anterior, superior, and inferior iliac spinous processes.—C, Pubic spinous process.—D, Uterine ligament.—E, Iliacus muscle in section.—F, Anterior crural nerve, cut.—G, Psoas muscle in section.—H, Femoral artery, cut.—I, Femoral vein, cut.—J, Herniary sac.—J*, Fascia propria.—K, Gimbernat's ligament.—L, Articular head of femur.—M, Ramus of ischium.

Fig. 2.—Posterior view of fig. 1.—A, Anterior superior iliac spinous process.—B, Transversalis fascia.—C, Facet of symphysis pubis.—D, Uterine ligament.—E E, Iliacus muscle.—F, Peritonæum; f, that membrane forming the neck (J J K) of the herniary sac.—G, Psoas muscle.—H, External iliac artery.—I, External iliac vein.—J J, Herniary aperture at the crural ring.—K, Situation of external inguinal ring.—L, Spinous process of ischium.—M, Urinary bladder fallen and collapsed.—N, Crus clitoridis.

Fig. 3.—The constricted bowel of a femoral hernia, retaining its form after removal from the embrace of the femoral ring.—A A, Abdominal parts of the small intestine.—B, The constricted part.—C, The herniary part.—D, The mesenteric part.

Fig. 4.—External inguinal hernia in the female.—A, Anterior superior iliac spinous process.—B, External inguinal ring.—C, Falciform process.—D, Herniary bowel, with omentum in the inguinal canal.—D*, Herniary bowel, with omentum protruding through external ring.—E E*, Herniary sac and fascia propria.—F, Conjoined tendon.—G G, Inguinal aponeurosis.—H, Saphena vein.—I I I, Inguinal and femoral lymphatic bodies.

Fig. 5.—Inguinal and Femoral herniæ coexisting in the Female.—Other parts marked as in fig. 4.—I, Femoral artery.—J, Femoral vein.—K, Anterior crural nerve.—L, Femoral hernia in the canal (L*), protruding through saphenous opening.—M, Pubic spinous process.—N, Uterine ligament.—O, Sartorius muscle.—P, Fascia covering adductor muscles.—Q, Pubic arch and symphysis.—R, Gimbernat's ligament constricting L, the herniary sac.

swelling. This is the condition of that part of the hernia, however large and in whatever situation its fundus may afterwards be. From this stage its further progress is determined by the anatomical condition of the parts contiguous to it. It cannot descend the femoral canal further down, for the walls of this part become closely applied to the femoral vein; and it will rather force its way through the saphenous opening, within which the inner wall of the canal is weak and unsupported. This part it next passes, either by rupture or by dilatation, and appears at the saphenous opening as a rounded swelling, the outer side of which is bound down by the falciform process. In general the hernia dilates the inner side of the canal, and this part becomes then its fascia propria. If it have ruptured the canal, the sac appears of course without any such covering. In either case the hernia, increasing in size, turns forwards and upwards over the margin of the falciform process, and ultimately rests upon the pubic third of the femoral arch, over or outside the external inguinal ring. It would appear to be the cribriform part of the superficial fascia attached to the falciform process which turns the hernia thus upwards, and perhaps this course is also given to it by the saphena and other superficial veins, which enter the saphenous opening always below the hernia, and by the mass of lymphatic bodies here situated. The hernia, rising at the saphenous opening, takes its third (fourth, if the subserous tissue is to be counted) covering from the loose cribriform part of the superficial fascia masking the saphenous opening. Directing notice now to the general form of the hernia as determined by the course it has taken when completely developed, it will appear of three parts, bent at acute angles to each other—the first part, in the femoral canal, is straight; the second part, turning forwards through the saphenous opening, is bent in respect to the first; and the third part—its fundus, resting on the femoral arch, is bent in respect to the second. Those three duplicatures are caused by the parts forming the saphenous opening holding their place while the hernia is passing by them. The bloodvessels with which the hernia is in close relationship are the following: its neck has the epigastric artery close above it, and the spermatic vessels separated from it only by the femoral arch, which at this part is turned nearly horizontal, and forms the inferior side of the inguinal canal. Not unfrequently the obturator artery arises from the epigastric, and descends close to the outer side of the neck of the hernia; in some instances it has been seen arching the neck, and behind Gimbernat's ligament. Within the femoral canal the herniary bowel is separated from the femoral vein only by the sac and the septum, which latter is the outer portion of the canal. When past the saphenous opening the hernia is crossed by the superficial pudic artery and by the hypogastric vein, while below it the saphena vein joins the femoral. When the fundus of the hernia is at the external ring, it again comes into apposition with the spermatic vessels, and if the hernia be large and rotund, the spermatic cord descends, touching its inner side. This relation of the hernia to the vessels is (excepting the spermatic) the same in the male and the female.

The co-existence of inguinal and femoral hernia in the same individual is by no means uncommon. We find it occurring in the female as well as in the male, and more usually, perhaps, in the former sex. This difference would seem ascribable to the circumstance that, while the femoral hernia is more common in the female than in the male, and the inguinal hernia more so in the male than in the female, the inguinal hernia happens in the female more frequently than the femoral does in the male. The anatomical reason for this evidently is that the female inguinal rings and canal are not so often preventive of hernia as the male femoral ring and canal. The internal inguinal ring in both sexes is pretty much of the same area, though transmitting the spermatic vessels in the one, and only the uterine ligament in the other, whereas in all instances, the femoral ring is wider in the female than in the male. But the point of most practical interest to observe is that, as in the case of double inguinal hernia, the femoral and inguinal counteract the development of each other. We seldom find a complete protrusion of the bowel at the saphenous opening in an individual affected with scrotal hernia; and when the former exists, the inguinal hernia, if it have taken place at all, seldom presents itself beyond the inguinal canal. The cause of this is that the inguinal and femoral rings are so close together that the same coil of bowel covers them, and therefore the more it protrudes through the one ring the less it can protrude through the other, and thus the greater hernia always tends to the reduction of the lesser. This remark cannot hold true of the omentum and the bowel, for those parts being distinct, may, on becoming herniary through different rings, progress outwards independently of each other. But it would seem that the hernia of either part occupying the one ring does in some degree contract by its pressure the other ring, and thereby prevent protrusion through the latter.

The diagnosis of one variety of femoral hernia from another scarcely needs a comment, for the two so seldom exist together. And when any variety of the complaint happens alone, its locality will generally suffice to distinguish it from any other. An incipient femoral hernia within the femoral canal is difficult to recognise in all individuals, because, being bound down by the fascia lata, it forms no superficial swelling, and often, only for the first time, has been known to exist when the symptoms of strangulation appeared. An inguinal bubonocele is likewise masked by the aponeurosis of the oblique muscle, which resists its swelling, but never so much as the fascia lata covering an incipient femoral hernia. The diagnosis of femoral from inguinal hernia may be best ascertained by considering in contrast the respective positions assumed by both. As the femoral ring is immediately below and between the two inguinal, the relation which they have to the inguino-femoral groove will give the distinction of the herniæ transmitted through them, provided one or the other forms a visible tumour. A femoral hernia cannot possibly be mistaken for an inguinal bubonocele till the former has proceeded to its full limit near the external ring. But even then their distinctive features are very well marked, for the inguinal hernia is ill defined behind the aponeurosis of the oblique muscle, and is above the femoral arch, while the femoral hernia, being superficial to those parts, is moveable upon them, may be withdrawn from them, and presents its body traceable to where it sinks into the saphenous opening more distinctly on the thigh than any form of inguinal hernia can ever be. An inguinal hernia manifests its proper character more and more plainly as it advances from the external ring to the top of the testicle in the scrotum. If it be of the external kind it will appear as descended within the sheaths of the cord, and the spermatic vessels will be behind it: if it be of the internal kind, the cord will be on its outer side. A femoral hernia in the male, when appearing through the saphenous opening, has the cord on its inner side invariably; and whether the male or the female be the subject of it, or whether or not it exists with an inguinal hernia, if it merely occupies the saphenous opening, it appears so evidently on the thigh, below the femoro-pubic groove, that its special nature becomes at once evident. A complete femoral hernia is globular in form; an inguinal hernia is pyriform, and even when the two touch each other, the inguino-femoral groove corresponding to Poupart's ligament remains in some part unobliterated between them, however obese or emaciated the individual may be. But though a femoral hernia, when developed to its full stage, may in general, with ordinary judgment, be distinguished as such by the place of the swelling, this outward sign does not attend the hernia in the first stage of its formation, when it protrudes merely into the femoral canal, and where, occult, it may suffer strangulation, and thereby be followed by effects just as evil as those resulting from its strangulation when of the largest size. The same may happen in the inguinal region, where the hernia is so small as to form no appreciable swelling in any case, and more especially when the subcutaneous adipose tissue is abundant. Under those circumstances it becomes impossible to tell (even when the general symptoms declare the presence of the hernia somewhere) at which of the three rings it protrudes, so close are they together, or whether it protrudes through either of them at all. That it does not do so may be best certified by its presence elsewhere, and hence the necessity of a general examination of the body.

The diagnosis of femoral hernia from other diseases which may happen in its usual locality, is occasionally required. *The lymphatic bodies*, situated in a mass at the saphenous opening, would on freely suppurating resemble the hernia as to the form of the tumour, its place, its tenderness on pressure, and its soft elastic feel. Their distinction is in such case to be known by the only physical sign, that of fluctuation, which attends the abscess; though even this would not answer if the herniary sac, as frequently happens, contained serum. The general symptoms and the history of each affection—the past or present existence of some cause of irritation of the lymphatic bodies, and the presence in some degree of visceral obstruction from the hernia, must then serve to distinguish them. *A fatty tumour* overlying the saphenous opening, and being prominent, circumscribed, soft, elastic, and as if fluctuant, would resemble a femoral hernia so closely as only to be distinguished from this by its history, its time of growth, and its being unaccompanied by visceral impediment. Such a tumour is not uncommonly found in the axilla, and the close analogy between that region and the groin is anatomically expressed. *The femoral veins* at the saphenous opening are liable to *varicosity* from the obstructing pressure of an ovarian or other abdominal tumour, as also from the gravitating pregnant uterus. In this state the

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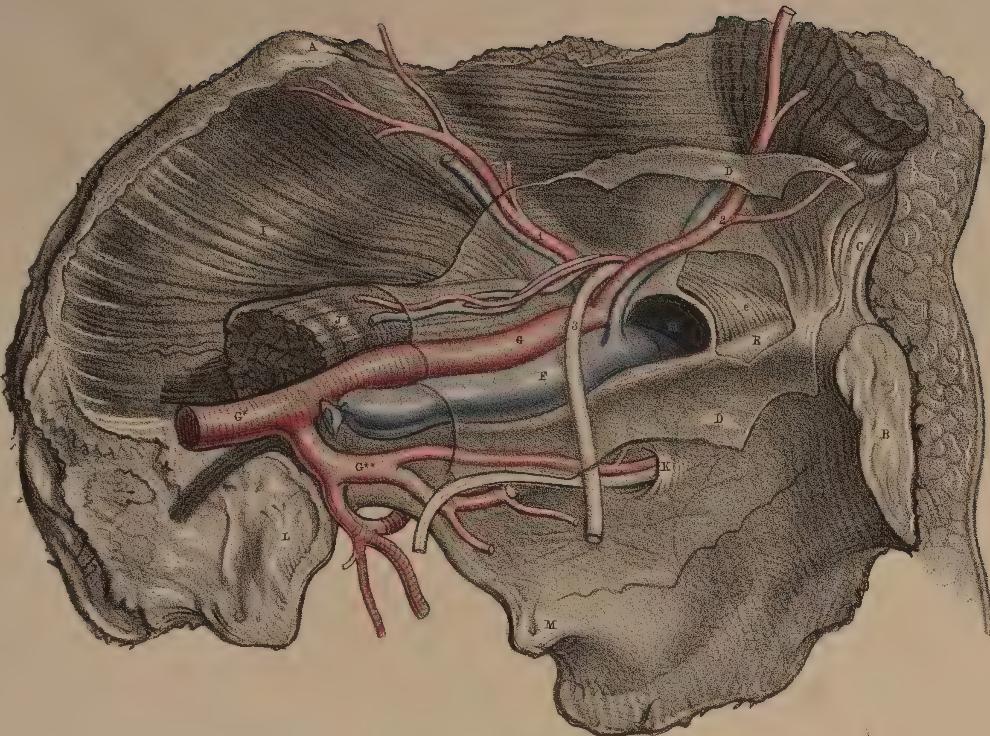
Fig. 2.



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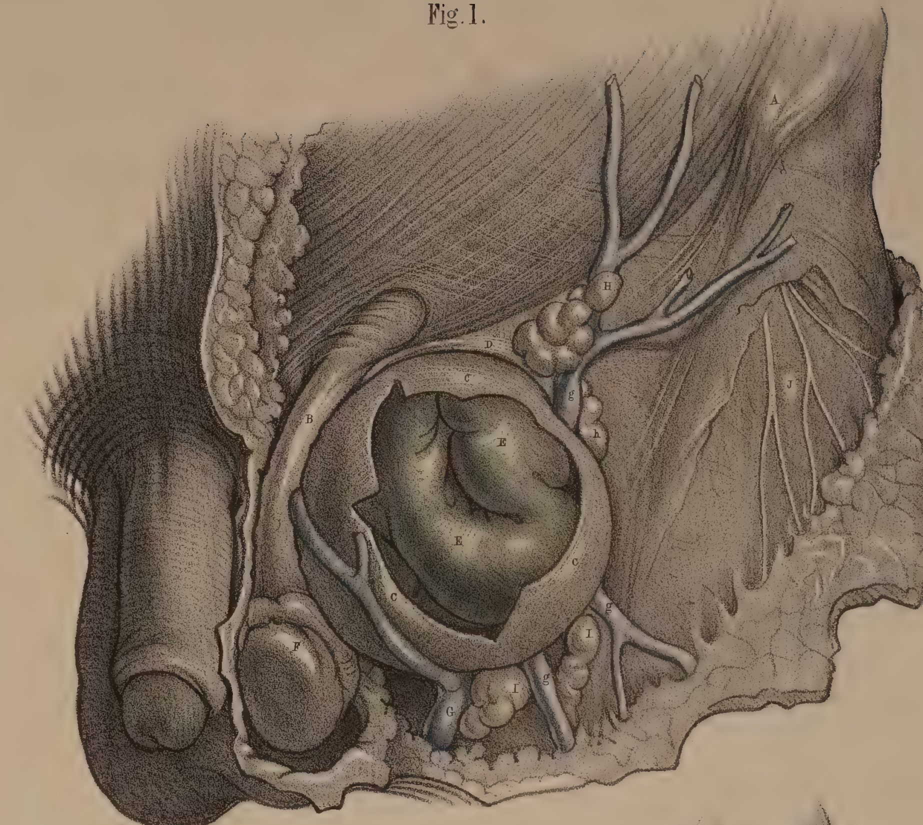

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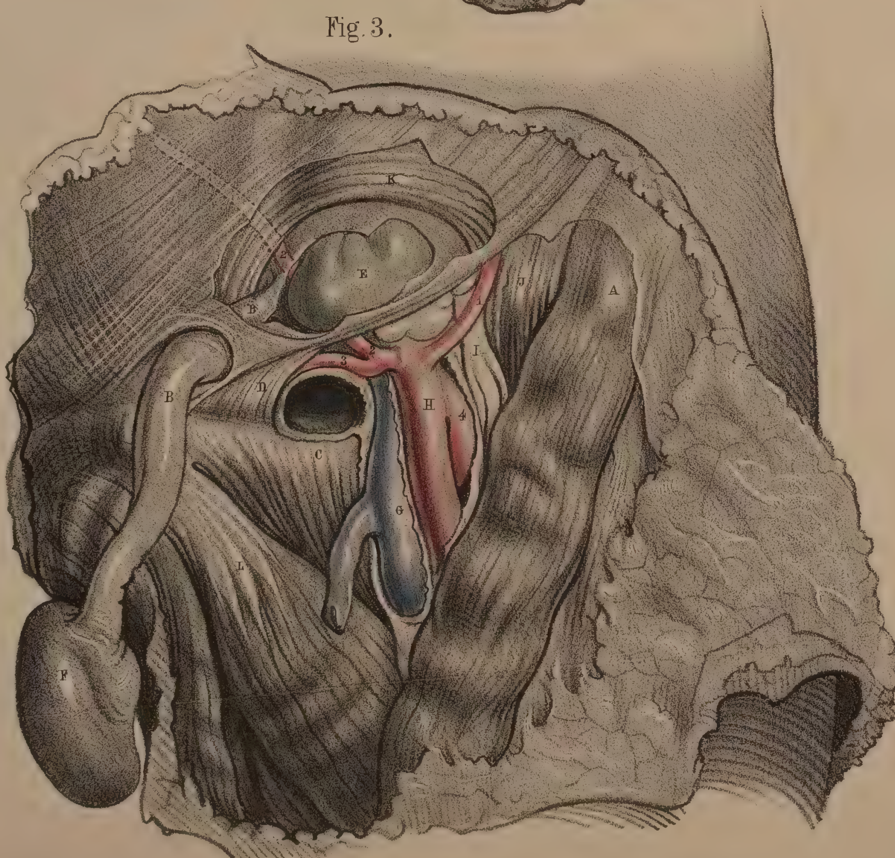
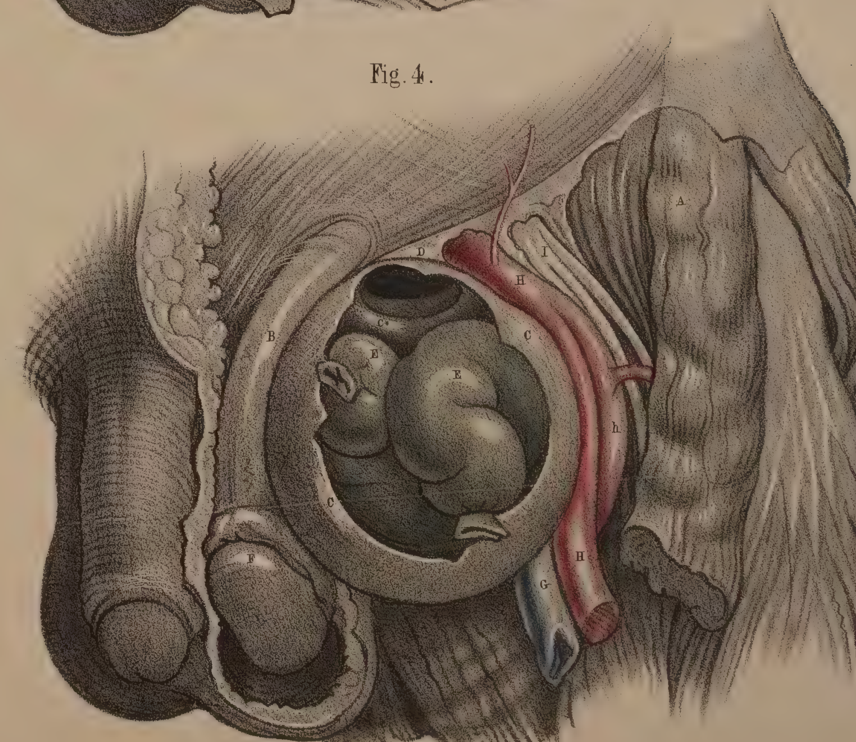


Fig. 4.



veins are said to simulate, in form, a femoral hernia, and, like this, to dilate perceptibly on coughing; but the cause being known, will leave no doubt as to the nature of the effect. *Aneurism* of the common femoral artery will appear as a circumscribed tumour in the neighbourhood of the saphenous opening, or projecting through it like a hernia; but the cardiac impulse and the other signs of aneurism are at all times clearly characteristic of that disease. *Psoas abscess*, from caries of the vertebræ, or *pericæcal abscess*, from caries of the iliac bone, when pointing below Poupart's ligament on the thigh, in the course of the femoral vessels, may appear like a femoral hernia as to form, size, and situation, also by the dilatation and the sense of impulse when the patient is made to cough. In general, however, the tumour of the abscess is external to the vessels, whereas that of the hernia is generally internal to them; and the former is, moreover, always fluctuant, while the latter is tympanitic, except when its sac contains serum, or when the bowel is distended with the matter. That the case is one of abscess instead of hernia will be always evident from the constitutional symptoms, even if the physical signs be less distinctive of either than they usually seem.

The seat of stricture of a hernia transmitted through the femoral ring and canal is always in close proximity with the neck of its sac. In this particular the femoral hernia is anatomically more like the direct than the oblique inguinal hernia; and the two former are, besides, protruded through structures of fibrous substance only. But the femoral hernia is, owing to the disposition of the parts encircling its neck, much more liable to constriction than either of the inguinal varieties. To specify any single band of fibrous tissue as being the sole agent of constriction in a femoral hernia, must, from its exclusiveness, be productive of some error. The close relations of the parts show clearly that several of them participate in causing that result. The conjoined tendon, the deep and superficial femoral arches, with Gimbernat's ligament, having a common insertion into the pectineal ridge of the os pubis, and the falciform process of the saphenous opening being immediately in front of them, and connected with them and with the pubic spine, renders it evident that all those parts together bind the neck of the hernia, and that, for the liberation of it, they have all to be divided. Those parts in union overarching the hernia, resist it in all instances by a sharp edge, which abruptly indents it more or less, and, according to the degree in which they encroach upon it, narrows the intestinal canal, the continuity of which is not unfrequently maintained by only a mere slit. Neither the rounded ramus of the os pubis nor the septum of the femoral sheath which separates the intestine from the femoral vein, and which lies in a plane sidelong with the hernia, can ever offer such a kind of constriction, though they form immovable barriers to its expansion. But while the structures which form the femoral ring thus unyieldingly resist the hernia at its neck, the peculiar sinuous course which it takes from its point of origin to its place on Poupart's ligament is, in addition, a very principal reason why this hernia is so frequently strangulated. The neck of the sac is never of greater girth than the original area of the femoral ring; it cannot be, for, unlike what may occur at the inguinal rings, the weight of the hernia cannot operate for its distension. A femoral hernia, however large, does not hang gravitating towards the median line, like an inguinal hernia, and it is to this kind of force that the gradual dilatation of the neck of the latter is principally due. The neck of the femoral hernia may, therefore, be considered as always suffering from constriction. The part which occupies the canal is also much compressed; and again, where the hernia has advanced so far as to turn over the falciform process, this part gives it a sharp duplicature, which of itself causes a considerable impediment to the canal of the bowel. This hernia is always affected by stricture of the *passive* kind—the fibrous bands with which it is in connexion compressing it rather by withstanding inertly the force of its protrusion, than by reacting against it. There are no muscular fibres crossing at any point of its course, and the bowel itself is the only part which manifests *action*. In the femoral hernia, therefore, much more than in the inguinal, it is of importance to note the difference between constriction and strangulation—the latter state being effected as the result of an action solely of the bowel itself, which, after entering the femoral canal, becomes of larger proportions than while entering it; and owing to its reception of the intestinal matter, to the accumulation of its serous secretion, and to the obstruction of its circulating vessels. Giving all due regard to this circumstance, the replacement of the bowel by the taxis or by the cutting operation will be effected with the more facility.

The taxis is a procedure which oftener fails of success in respect to a femoral than to any other of the ordinary kinds of hernia. This result is due more to the anatomical than to the pathological condition of the parts concerned in the femoral hernia. In addition to such causes as an adhesion of the bowel to the sac, and which are as liable to occur in the one variety of the complaint as in the other, it is true that the body and fundus of a complete, fully-formed femoral hernia bear a much greater proportion to its neck than is manifested in regard to those parts of an inguinal hernia. The latter oftener attains a greater bulk on the whole absolutely; but in the degree of its increase in volume there occurs an increase in the area of its neck, owing to the traction which, by its pendent weight, it exercises on the apertures transmitting it; but this result never accompanies a femoral hernia, for the causative force is absent. The neck of a femoral hernia remains of the same width as originally, however great the size which the protruded part has attained; and consequently the greater the volume of the protrusion, the greater the difficulty of its reduction. Besides this, the neck of this hernia is very deeply situated, and out of the command of the hand; whilst, moreover, the frequent bends which it makes in its advance outwards from the embrace of the binding parts, prevent the possibility of exercising compressing force directly towards its neck, which cannot otherwise be influenced; and if not this part, no other part of it, however urged, can tend to the reduction. On this account I am inclined to believe that the supine posture, which induces the herniary viscus to follow by traction the internal gravitating organs, and the compression by which the bowel and sac are partially unloaded of their contents, serve more especially for the reduction of this kind of hernia than of any other. In aid of those means, the relaxation of the inguino-femoral region will no doubt contribute much; but as to the impulsion of the hernia by the operator's hand from before backwards, that act, *per se*, can be of no useful effect, for reasons before noticed. And of what effect either the bath or medicines can be in loosening the constricting structures of a femoral hernia especially, I cannot, for my own part, conceive, seeing that those structures are of fixed, inert, fibrous tissue. If the latter means can prove to be anything more than a *pis aller* in practice, why have they so often failed, even with the most judicious manipulators, and when (as proved in the cutting operation afterwards undertaken) no adventitious product existed to hinder the replacement of the bowel? We may give to a luxation of a joint and to a hernia, with equal propriety, the name *dislocation*, so far as the part in either case is unseated from its normal position; and *reduction* may be the term fittingly enough applied to the replacement of either part; but while, in respect to the joint, we can plausibly admit and experience the advantage of relaxing muscles by physical and therapeutic agents, neither reason nor experience seems to indicate the reduction of a hernia on that principle; for as muscular fibre in nowise tended to prevent the protrusion, so muscular agency cannot be supposed to hinder its reduction. The femoral hernia has no immediate connexion with muscles, except by its passage through or aside of their tendons and tissues similar to tendons which, from their nature, can admit of no relaxation, if this be

FIGURES OF PLATE XXXVII.

Fig. 1.—Femoral hernia in the male.—A, Iliac anterior superior spinous process.—B, Spermatic cord.—C, Hernial sac.—D, Falciform process of fascia lata.—E, Herniary intestine.—F, Testicle.—G, Saphena vein; g g g, tributary branches.—H, h, Inguinal lymphatic bodies.—I I, Femoral lymphatic bodies.—J, Fascia lata and branches of external cutaneous nerve.

Fig. 2.—Posterior view of the femoral hernia.—A, Iliac spinous process.—B, Facet of symphysis pubis.—C, Rectus abdominis muscle.—D D, Peritonæum.—E, Horizontal ramus of pubic bone, with e, Gimbernat's ligament attached to its pectineal ridge.—F, External iliac vein.—G, External iliac artery; G*, Common iliac artery; G**, Internal iliac artery.—H, Neck of the hernial aperture.—I, Iliacus muscle.—J, Psoas muscle.—K, Obturator foramen transmitting the artery and nerve.—L, Iliac facet of sacro-iliac junction.—M, Spine of ischium—1, Circumflex iliac vessels; 2, Epigastric vessels; 3, Vas deferens, with spermatic vessels.

Fig. 3.—Anterior view of the femoral ring, and neck of the femoral hernia in the male. —A, Sartorius muscle.—B, Spermatic cord.—C, Horizontal ramus of os pubis under hernial aperture.—D, Gimbernat's ligament.—E, An incipient external inguinal hernia.—F, Testicle.—G, Femoral vein.—H, Femoral artery.—I, Anterior crural nerve.—J, Iliacus muscle.—K, Internal oblique muscle of abdomen.—L, Adductor longus muscle—1, Circumflex iliac branch arising from common femoral artery; 2. Epigastric branch arising from the same vessel; 3, Obturator branch arising from the Epigastric, and arching over the neck of the hernia, to descend on its inner side behind D, Gimbernat's ligament.

Fig. 4.—A view of the deeper parts of fig. 1.—A, Sartorius muscle.—B, Testicle.—C C, Hernial sac.—C*, Neck of hernia in the femoral ring.—D, Falciform process.—E E, Herniary bowel.—F, Testicle.—G, Femoral vein overlaid by the femoral hernia.—H H, Femoral artery; and h, Profundus branch distorted outwards by pressure of the hernia.—I, Anterior crural nerve.

not attainable by the passive motion of the limb to a particular position.

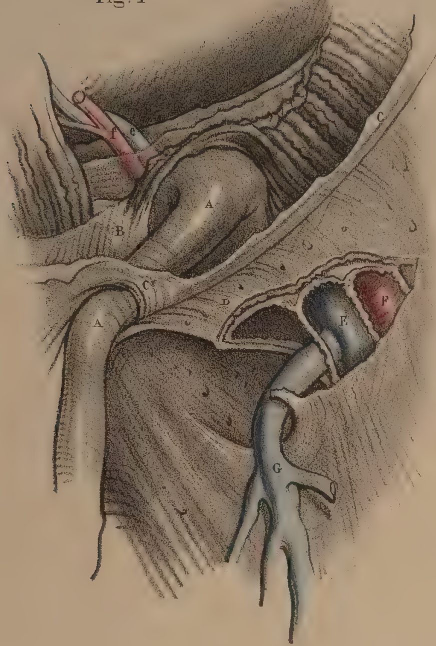
When the thigh is bent inwards to the hypogastrium, while the body is supine, the fascia lata and the inguinal aponeurosis are relaxed, together with the femoral arches between them. This may also render Gimbernat's ligament in some degree less tense than previously, but I doubt if the situation and connexions of this part, and of the structures combined with it, can be so far influenced by the position as to facilitate in any very material degree the reduction of the hernia; for the truth is (as we find on inspecting the parts in the dead subject with which relaxation is complete), that the diameter of the femoral ring remains the same under all circumstances. The adduction and flexion of the thigh effects, however, in a marked manner, the relaxation of the falciform process; and this condition of the part affords the manipulator a more immediate command over the herniary portion in the canal and ring, and facilitates the diminution of the herniary contents by the compression exerted. If this decrease in volume cannot be effected, it stands to reason that impulsion backwards, even in the proper anatomical direction, can be of no avail, for the herniary mass outside the femoral ring is many times greater than the ring itself in girth, and therefore the re-passage of the hernia amounts to a physical impossibility. The frequency of failure in the reduction of this hernia by the taxis is simply owing to that circumstance. It is only inasmuch as the force exerted in the mode of impulsion induces the same result (a lessening of the herniary quantity) as compression, that success attends the taxis. But as that result cannot be realized by either kind of force, except according to the anatomical relations of the parts, this subject demands consideration likewise. Supposing the hernia to rest upon the falciform process, and touching Poupart's ligament, it is evident that, if the tumour be urged in the same direction, it must tend not only to increase the protrusion by a dragging extension of it from under the process, but also to injure it against the opposing edge of that part. Therefore, the fundus of the hernia requires, in the first place, to be withdrawn from its superficial situation at the groin, and brought below this part to within the compass of the saphenous opening, in order that its contents may be repassed, under the falciform process, towards the femoral ring; and now, in the degree that compression reduces the herniary contents, of whatever kind they are, the traction of the bowel backwards by the gravitation of the parts in the abdomen, will be felt to accomplish the end desired. In its retreating, the bowel emits a gurgle, clearly indicating that its motion is one of traction only; and in order to promote this motion, it is evident that the pelvis and loins should be supported at a higher level than the thorax, at the same time that the thigh is flexed inwards. Upon this principle of position I lately effected the reduction of a femoral hernia in the female, while the surgeon was arranging his operating apparatus.

The operation for the division of the parts which constrict a hernia in the femoral canal should be so conducted that the incision through the integuments may admit of reaching those parts with most facility. They are always to be found on the inner side of the neck of the sac, and this, fortunately, is the place where the incision may be made with least danger to important bloodvessels. The fibrous bands constituted of the conjoined tendon, Gimbernat's ligament, and the upper cornu of the falciform process, are the parts which sharply indent the neck of the hernia; but it may be presumed that the bowel suffers constriction throughout the whole length of the femoral canal. In both sexes, the situation of the femoral vein close to the outer side of the neck of the sac, and the os pubis under it, render the upper and inner side of the femoral ring the only available places for incising it safely and effectually; but in the male the spermatic vessels, here descending, forbid too free an incision, while in the female the uterine ligament—a structure of no such importance—alone exists. When, however, we take into consideration that the bladder, in its distended state, rises above the pubes behind the femoral ring, and that the obturator artery derived from the epigastric occasionally bends over the neck of the hernia, it will appear that there is no direction in which an incision of the femoral ring can be recommended free altogether from objection. The bladder may, however, be placed out of danger by emptying it, as it then collapses below the pubes; but if that variety in the course of the obturator artery exists, what anatomical knowledge can direct the bistoury so as to avoid wounding it?

The incision through the skin, if made in reference to the constricting parts, should commence at a point a little to the outer side of the external inguinal ring, and be carried thence vertically over the hernia parallel with, but to the inner side of, the middle of its fundus. From the upper end of this incision, another shorter one should be made, corresponding with the pudic third of Poupart's ligament, so as to allow of the skin being drawn apart, to reach in the after stages of the operation the seat of stricture, which is very deep. This second incision will be found of advantage, in enabling the operator to prevent the neck of the hernia swelling about the bistoury when within the stricture, that thereby the bowel may escape being wounded. The skin having been divided, the subcutaneous adipose substance above and below the femoro-pubic fold, and which varies in quantity considerably in different individuals, should be cut in the same manner. In doing so, one or two small arteries and veins (superficial pudic) may bleed, and some lymphatic bodies be exposed. Beneath the adipose tissue and the superficial fascia, the fascia propria of the hernia will next appear, when present; but this is not always the case, either as a consequence of a rupture of it, or a thinning of it by the herniary protrusion. The fascia propria, in most instances, so adheres to the sac, that the two have to be treated as one membrane, whether it be found necessary to divide them or not. When the fibrous and serous membranes are so connected, of course, if it be not proper to open the latter, there can be no necessity for dividing the former. But sometimes the two coverings are separated by an intervening layer of fatty substance which so much resembles omentum, that when the fascia propria is divided, this membrane then revealing the fat, may be mistaken by the operator for the serous sac itself, and the case for one of omental hernia. This layer of adipose substance is generated in the meshes of the sub-serous cellular membrane; it is more frequently found in the oblique inguinal and the hernia which occupies the femoral canal, than in any other; and this may be accounted for anatomically: Both these herniæ when about to form take their fascia propria from the tubes of fibrous membrane investing the vessels whose course they respectively follow; and the sub-serous tissue which fills those tubes is already sufficiently abundant to form a distinct investment for the herniary bowel, and (when loaded with fat) to keep the serous and fibrous envelopes separate. In such a case, the fascia is to have a director passed under it, and to be cautiously slit open on that instrument, so as to bring the true serous sac in view, as far up as the femoral ring, if possible. This being done, and the hernia having been drawn downwards and apart from the inner side of the ring and canal, the director—a flat broad one—or the tip of the left forefinger, is now to be passed through the ring, at the interval made; the groove of the director, if that be used, being of course turned from the hernia. The position of the director being now between the neck of the hernia and the inner arc of the ring, that instrument may be considered as including all the constricting structures, except the neck of the hernial sac; and now when the probe-pointed bistoury is slid along the groove of the director, both instruments forming an acute angle with each other, and the cutting edge of the bistoury turned upwards and inwards, the following-mentioned parts are to be divided successively, but each to such extent only as it will be felt to constrict—viz., the upper cornu of the falciform process, with that part of the inner side of the canal beneath it, and next more deeply situated, the fibrous band formed by Gimbernat's ligament, the deep femoral arch, and the conjoined tendon; and, if necessary, the contiguous part of the superficial femoral arch, taking care not to wound (in the male) the spermatic vessels. The inward direction of the incision gives security to the epigastric artery, so that if any important vessel be found to bleed, it is in all probability that variety of the obturator already noticed, and to secure it will demand an extension of the incision so that it may be reached. The constricting parts now named being severed, a trial to restore the hernia to the abdomen is to be made, when, if any impediment still remains, the cause of it is either a thickened state of the neck of the sac to which the bowel may be adhering, or bands of false membrane may connect the sac and bowel elsewhere. In either case it will be necessary to open the sac and examine its contents; and in doing so, that necessity may appear for other cogent reasons besides: in a femoral hernia, more particularly, the bowel, where it has been girt by the unyielding ring, is apt to retain its constricted form even when liberated, and in this state it is to be regarded as effectually obstructed as previously to the operation.

In the operation for the femoral hernia now briefly described, when the principal requirements are kept prominently in view, they will furnish a rational answer to each of those questions which high authority appears to have left *sub judice*—viz., as to the precise seat of the stricture, and the propriety of opening the sac. With regard to the first question, there can be no doubt that, whatever other parts may be found during the operation to constrict the bowel, the femoral ring is and must always be a chief cause of that result; and as the inner side of that ring is the only part which, in the normal anatomy, can be safely incised,

Fig. 1



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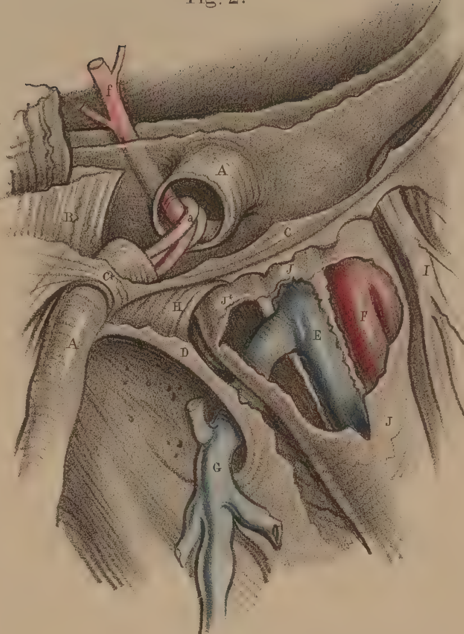
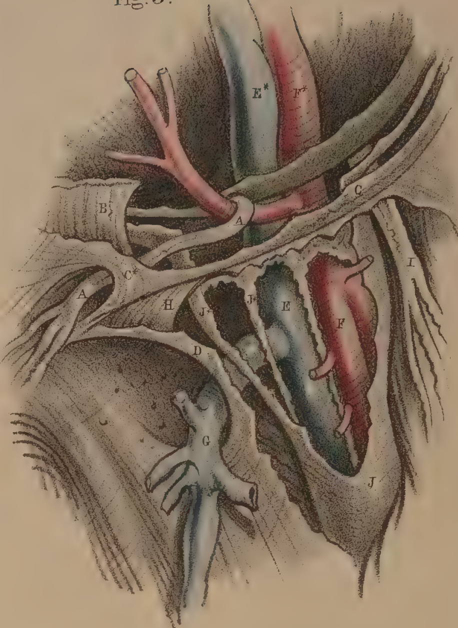


Fig. 3.



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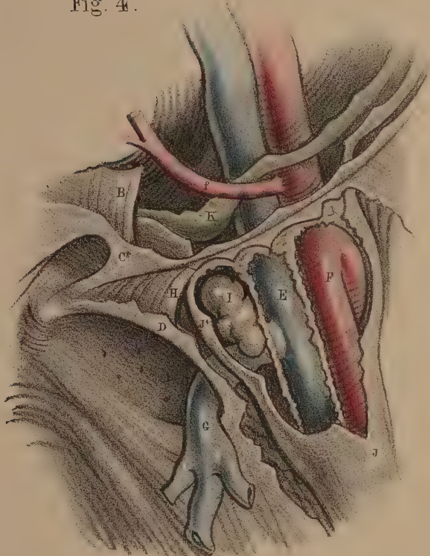

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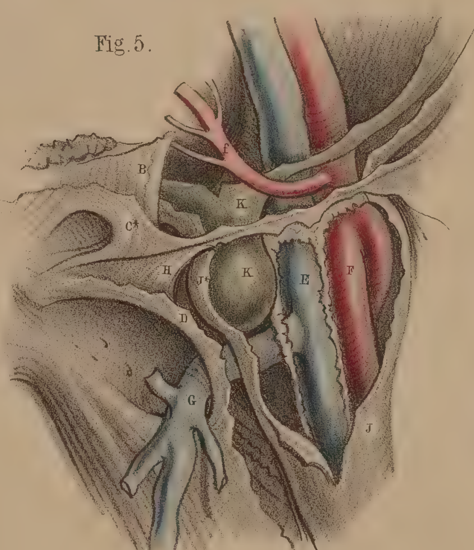

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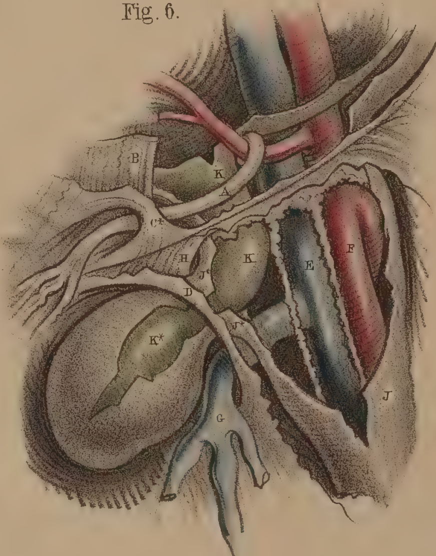


Fig. 7.

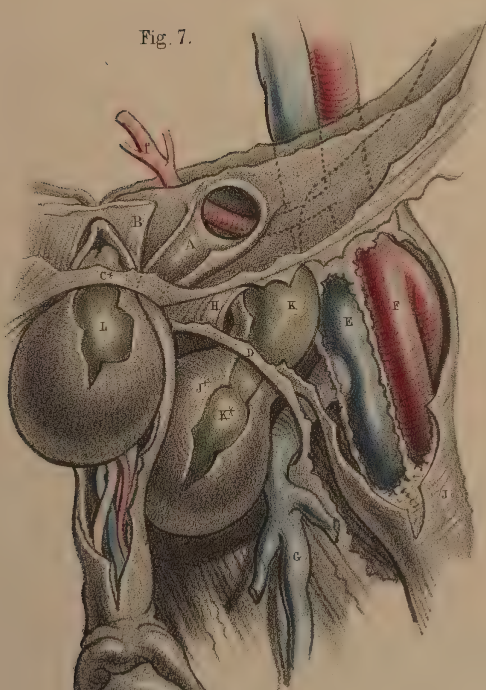


Fig. 8.

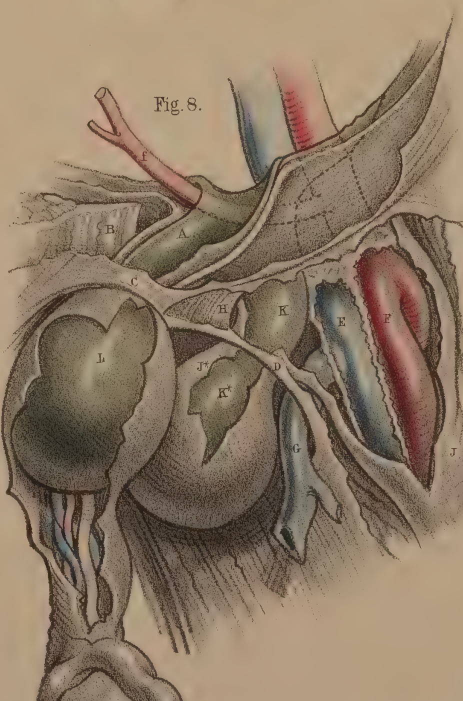
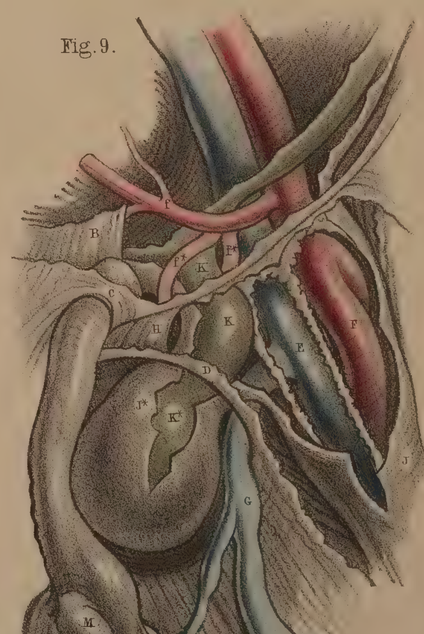


Fig. 9.



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and with all the required effect, this must ever determine the necessary course of proceeding. With regard to the second question, the answer would appear to turn not upon the ill or harmless consequence of a wound of the serous sac in one instance, or the maintenance of its integrity in the other, but rather as respects the state of its contents. When the sac has not been opened, the result of the operation has, we know, not always been successful; and when it has been opened, the issue has not, we also know, ever been fatal; and thus with the opposite forces of facts regarding the condition of the sac neutralising each other, it surely is not without good reason that we may consider the bowel itself to be the real subject at fault, in whatever state its envelope exists. To liberate the strangulated bowel is in all cases the urgent necessity; and it is this organ which, however seemingly well the operation has been performed, is still the sole cause of ill consequence threatening. It is admitted that many necessities require the sac to be opened in order to inspect the state of the bowel, but who can say that some one of those necessities does not exist if the sac be left entire? To assure oneself of this is to know a truth; to neglect or to fear doing so is to sacrifice a certainty to a doubt; for who will assert that what the unopened sac concealed did not alone induce the fatal issue, or that what the opened sac revealed was not alone the cause of that issue, which would have followed whether the sac were left entire or not? While therefore it has yet to be proved that a wound of the sac is a source of danger to the success of the operation, and while, moreover, it would seem that the proofs of that nowhere exist, or are lost to sight in presence of dangers so obvious as to declare cause and effect at once to the weakest comprehension, let us not incur the real danger in our avoidance of the supposed one. In the latter stages of the operation for femoral hernia, and indeed for all other

FIGURES OF PLATE XXXVIII.

Demonstrations of the Origin and Progress of Femoral Hernia, and of the Operation, &c.

Fig. 1.—When we divide the iliac part of the fascia lata transversely from the saphenous opening outwards over the femoral vessels, E F, we find the falciform process, D, to consist of a duplicature of that structure in reference to the vessels, and so disposed that they are between the folds. The saphenous opening is the result of this folding of the fascia from the front of the vessels to pass under them. Between the reflected layer of the iliac part of the fascia and the pubic part, which also passes behind the vessels, the saphenous opening is the valvular interval. This will explain that the saphenous opening is a space distinct from the femoral sheath. On dividing the femoral sheath in the same manner transversely, we find two septa separating it into three compartments, of which the middle one is occupied by the vein, E, the outer one by the artery F, the inner one being unoccupied. The form of the latter is struck by the falciform process of the fascia between the folds of which it is. The inner compartment, that between the falciform folds, is the femoral canal; and while the parts have the disposition now described, it will be seen that when a hernia descends the canal, it cannot protrude at the saphenous opening, unless by a dilatation or a rupture of both the inner wall of the canal and the inferior layer of the falciform fold.

Fig. 2.—The femoral ring, J*, and the two inguinal rings, A internal, and C* external, are generally so close together, that from a point midway between them a radius of half an inch would touch their proximal borders. In the erect posture the plane of each of the inguinal rings is nearly vertical, while that of the femoral ring is nearly horizontal, because of the femoral arches being in front of, and on a level with, the pectineal ridge of the pubic bone. Each ring gives, of course, a corresponding incline to the neck of the hernia, which it transmits. The femoral ring is, in most individuals, of either sex, nearer to the internal than to the external inguinal ring, for the first-mentioned part is immediately on the inner side of the femoral vein, E, while the second is close above that vessel, the two being separated only by the epigastric branches, *f*, of the femoral vessels passing under the middle of the femoral arch, C, the plane of which is horizontal. The necks of the external inguinal and the femoral herniæ have corresponding relations to those vessels. Between the neck of the femoral ring and the external inguinal, and concealed by the falciform process, D, the interval of half an inch, more or less, is occupied by Gimbernat's ligament, H, of the femoral arch, which lies nearly horizontal, forming the floor of the inguinal canal, and supporting the spermatic vessels, *a*. When a hernia has descended through the femoral canal, and bent inwards to appear through the saphenous opening, its body must be therefore separated from the inguinal canal by only Gimbernat's ligament of the femoral arch; and this part, limiting as it does the area of the femoral ring, must therefore necessarily always constrict the neck of the hernia; and in the measure of its division in an operation, not only will the neck of a hernia be liberated, but the passage of the protrusion between the ring and the saphenous opening will be rendered more direct, and the hernia less bent. This circumstance will render its reduction more easy. The position of Gimbernat's ligament, with the hernia outside it, the pubic bone under it, and the spermatic vessels above it, necessitates the division of it horizontally inwards; and as it is the part which, by its insertion into the pectineal ridge, gives tension to the femoral arch, its division will be found to render the arch in most instances sufficiently lax for the reduction of the hernia.

Fig. 3.—In the female, the femoral ring and canal have the same relations to each other, to the bloodvessels and other parts, as in the male. The chief feature in which this aperture in the former sex is said to differ from that of the latter, is in respect to Gimbernat's ligament, which structure, H, if usually less in transverse diameter, will cause the interval between it and the femoral vein, occupied by the femoral canal, J* J*, to be wider and more passable. But it is not generally true that Gimbernat's ligament is less wide in the female than in the male; and indeed, even if it were true, it must be obvious that the condition of that small part in the sexes is but a very narrow basis upon which to found a generalization as to the cause of their greater or less liability to this hernia. To the same cause that we fairly ascribe the difference as to form and position, in respect to the inguinal rings and inguinal canal, at different ages, we should ascribe the differences as to width, &c., of the femoral ring in different sexes; and upon that cause, also, naturally depends the relative frequency of the herniæ here occurring. In early life, the internal inguinal ring is nearly opposite the external, and directly above the femoral ring. As the pelvis widens gradually in the advance to adult age (and in the female it widens more than in the male), the inguinal canal becomes oblique in both sexes. This obliquity, which is itself a preventive of inguinal hernia, and which is due to a change of place, performed rather by the internal than the external ring, (the former, being drawn laterally by a lengthening of the pubic bone,) is more marked in the female than in the male; and thus accounts, with other facts, for the less frequency of inguinal hernia in the female sex. It is to the greater length of the pubic bone of the female, that the greater width of the femoral ring is also due, and consequently the greater liability of this sex to femoral hernia. Thus, while the female inguinal canal gains in preventive obliquity by that developmental cause, the female femoral canal gains in capacity, and loses in regard to security, by that same cause. The uterine cord, A A, being the only occupant of the inguinal canal of the female, allows of the femoral arch, C, as well as Gimbernat's ligament, being safely incised (if required) obliquely upwards and inwards.

Fig. 4.—The usual place of election for the formation of a femoral hernia, is determined by the ring being the weakest part; for the space which the femoral arch spans, external to the fibrous vessels, is fully occupied by the psoas and iliacus muscles; while the abdominal fibrous membrane and its prolongation, the femoral sheath, J, closely embrace those vessels on their outer, anterior, and posterior sides, and give septa between them. In many instances the femoral canal is occupied by a lymphatic body, I, and in others the inner wall of the canal, J*, is closely applied to the vein E, by Gimbernat's ligament, H, being of unusual breadth, so that under either circumstance the hernia cannot freely enter the canal. When the ring is wide, and the canal unoccupied, the peritonæum, K, and the sub-serous tissue (crural septum) form the only barrier against the protrusion of the bowel, and those membranes are at first dilated before the bowel in the form of a shallow cup, whose width is determined by the ring, and this is in no instance more than half an inch in transverse or antero-posterior diameter. The situation of the ring being below the root of the epigastric artery, *f*, and between the femoral vein, E, and Gimbernat's ligament, H, and having the femoral arches before, and the os pubis behind, those parts bound the neck of the hernia, nor are they further parted from each other by the weight or pressure of it, even in the most advanced stage of its progress. This circumstance explains the frequency with which this hernia is constricted, and the usual difficulty of reducing it by the taxis, or when, in an operation, the constricting parts have been too sparingly divided.

Fig. 5.—When the hernia, K K, merely protrudes through the femoral ring into the femoral canal, J*, the part below the ring presents itself scarcely, if at all, of larger girth than the part embraced by the ring. Its sac may now be considered as the dilated disc of peritonæum which originally closed the ring, and it is uniformly spread over the enclosed bowel. But the bowel itself is so compressed as to be thrown into deep folds, having no internal space. In this stage of the hernia—a protrusion of the bowel, involving only the free semi-circumference—its canal above the ring is still partially maintained, and the extreme urgent symptoms of strangulating obstruction do not as yet manifest themselves. By its further protrusion, a complete duplicature of the bowel enters the femoral canal; and now its circumference in two parts is girt by the ring, and consequently the continuity of its interior is wholly interrupted. While yet only entered the canal, this part, J*, forms the third investment of the bowel; and as the canal itself is within the falciform fold, D, of the fascia lata, this part may be regarded as the fourth investment. Thus far advanced, if the hernia happen to be strangulated, it is evident that the seat of stricture must be at the femoral ring. And as the hernia has always a tendency towards the pubes, through the saphenous opening, it must also be obvious that the most trenchant part of the stricture, as well by reason of its place as of its form, is Gimbernat's ligament, H, with the parts conjoined.

Fig. 6.—The hernia, K K K*, gradually increasing in size, becomes tightly impacted in the femoral canal, and will remain in this state, K, fig. 5, unapparent as a tumour subcutaneously, so long as the surrounding structures resist its expansion. The iliac fascia lata, of dense texture, binds it down anteriorly; the femoral vessels in the other compartments of the sheath resist it on the outer side; the adductor muscles support it behind; and it cannot protrude further down, sidelong with the vein, E, in the axis of the thigh, because of the femoral sheath, J, being here closely fitted to the vessels, and kept in that form by the fascia lata. The saphena vein, G, joining the femoral vein, may also contribute to prevent its downward advance. The hernia, therefore, being unable to dilate its canal uniformly to a size corresponding with its own volume, and being next to the saphenous opening, D, dilates the canal, J J*, on that side alone, or ruptures it, taking, in the former instance, as its fascia propria, the inner wall of the canal, and in the latter appearing devoid of that covering. Though protruding now at the saphenous opening from under the falciform process, it must, if dilatation be the mode in which it affects all opposing membranes, be still invested by the fascia lata as when within the femoral canal, for the deep fold of the falciform process was a distinct membrane opponent to its progress inwards; but this is an anatomical point of little practical import. The cribriform part of the superficial fascia masking the saphenous opening, it next takes as its fifth layer, and with it the adipose tissue and integument. When expanded through the saphenous opening, the hernia, K*, may be regarded as constricted in two situations, viz., at the femoral ring, and at the ring which itself has made in the inner side of the canal, J J*, where it is bound down by the falciform process, D. Between both situations the body of the hernia is compressed by the canal, and bent inwards at a right angle to its neck. In this position it is evident, from the form and the close relations of the constricting parts, that all incisions should be made at the pubic side of the hernia, for here the upper cornu of the falciform process is joining with the lower pillar of the external inguinal ring, C, and both conceal Gimbernat's ligament, H. Those three parts may be divided by an incision of half an inch in extent.

Figs. 7 and 8.—The femoral hernia, K K*, when fully produced, approaches the external inguinal ring, C*, through which both the inguinal herniæ protrude, and thereby simulates them. This it does in consequence of the peculiar form of the falciform process, D, describing the saphenous opening; and indeed it is the form of that process which principally contributes to the passage of the hernia through that opening, for it sweeps in a gentle curve from the pubic spine outwards to the situation of the femoral vein, about two inches below the middle of the femoral arch,—so that its inferior cornu is in a line directly under the femoral ring, and thus it leads the descending hernia inwards.

Fig. 9.—The neck of the femoral hernia, K, is always internal to, and below, the epigastric artery, *f*; but when the obturator artery is derived from the epigastric, the former vessel may be either internal or external to the neck. If internal, *f**, it can scarcely ever escape being wounded when Gimbernat's ligament, H, is being divided; if external, **f**, the vessel will probably be out of danger; for, on that side, the femoral vein and the root of the epigastric artery forbid the incision of the stricture ever being made. What determines the position of the obturator artery in respect to the neck of the hernia, is simply the position which it had in respect to the ring before the protrusion through this part occurred. When the obturator is given off from the root of the epigastric, it descends external to the ring; when derived further from the root of that vessel, it lies internal to it.

varieties of the accident, the greatest caution is necessary not to wound the bowel while the stricture is being divided. I have seen this accident often occur by the hands of the best anatomists, for want of forethought, but chiefly on account of the defective form of the director commonly used. That instrument is so narrow, that when it is passed under the stricture it becomes imbedded in the neck of the hernia, the sides of which rising elastic over the instrument, meet each other in front of its groove, and thus encounter the bistoury. This may be prevented by depressing the herniary part immediately in front of the stricture; but the part concealed behind it remains uninfluenced by that precaution, and is from the same cause still exposed to injury. What I would suggest as a more fitting director than any other—except the finger, which, at the same time that it guides the knife, can feel the stricture and guard the bowel—is a broad one with recurved borders to suit the form of the ring, and having its groove on its convex side. With such an instrument the knife could play free of the bowel in making the requisite incision (always to be a very short one in femoral hernia) of the stricturing parts.

Of the operation in respect to other anatomical varieties of femoral hernia, a few remarks will suffice. The passages through which they have protruded are generally so free that strangulation is unfrequent. If it be necessary to divide a part which causes constriction, the relation which the bowel has to the femoral vessels is to be considered. The particular part of the bowel which protrudes will, when recognised, determine the ultimate objects of the operation. If it be a hernia of the small intestine, and strangulated, the stricture is to be relieved and the bowel reduced; but the former procedure is all that can be accomplished when the hernia is one of the cæcum, the urinary bladder, and in some instances the sigmoid flexure of the colon; for the two former parts being but partially invested by peritonæum, never can have complete sacs, and consequently, their cellular surfaces becoming adherent to the tissues in all extra-abdominal situations, render reduction impossible.

The more usual situation in which, besides the inguino-femoral region, a hernial protrusion, spontaneously arising, manifests itself as a subcutaneous tumour, is at the umbilicus, or some point at the abdominal median line. In general, a hernia is occasioned here from a congenital defect of median closure, and in such case the viscus has but the integument and condensed cellular membrane for its capsule. In early infancy the abdomen is so capacious, relative to the pelvis, that the umbilical region overhangs the latter, and is the part consequently towards which the viscera most gravitate. When the umbilicus is not timely and firmly cicatrized after the separation of the cord, the weakness of the part is ever afterwards continued by the visceral pressure. In the pregnant female, too, with the form and relative capacity of the abdomen and pelvis the same, there is, from the like cause, a tendency to dehiscence at the abdominal median line, and particularly at the umbilicus; and hence the not uncommon occurrence of hernia through this part during and after that state. This hernia has been known to be the consequence of extreme obesity, not of the subcutaneous tissues, but of the omenta, the mesenteries, and other internal parts which protrude the front of the abdomen; but in such cases, it may be inferred that there was also an original weakness of the umbilicus, else why should this part withstand so effectually the even greater distension manifested in ascites?

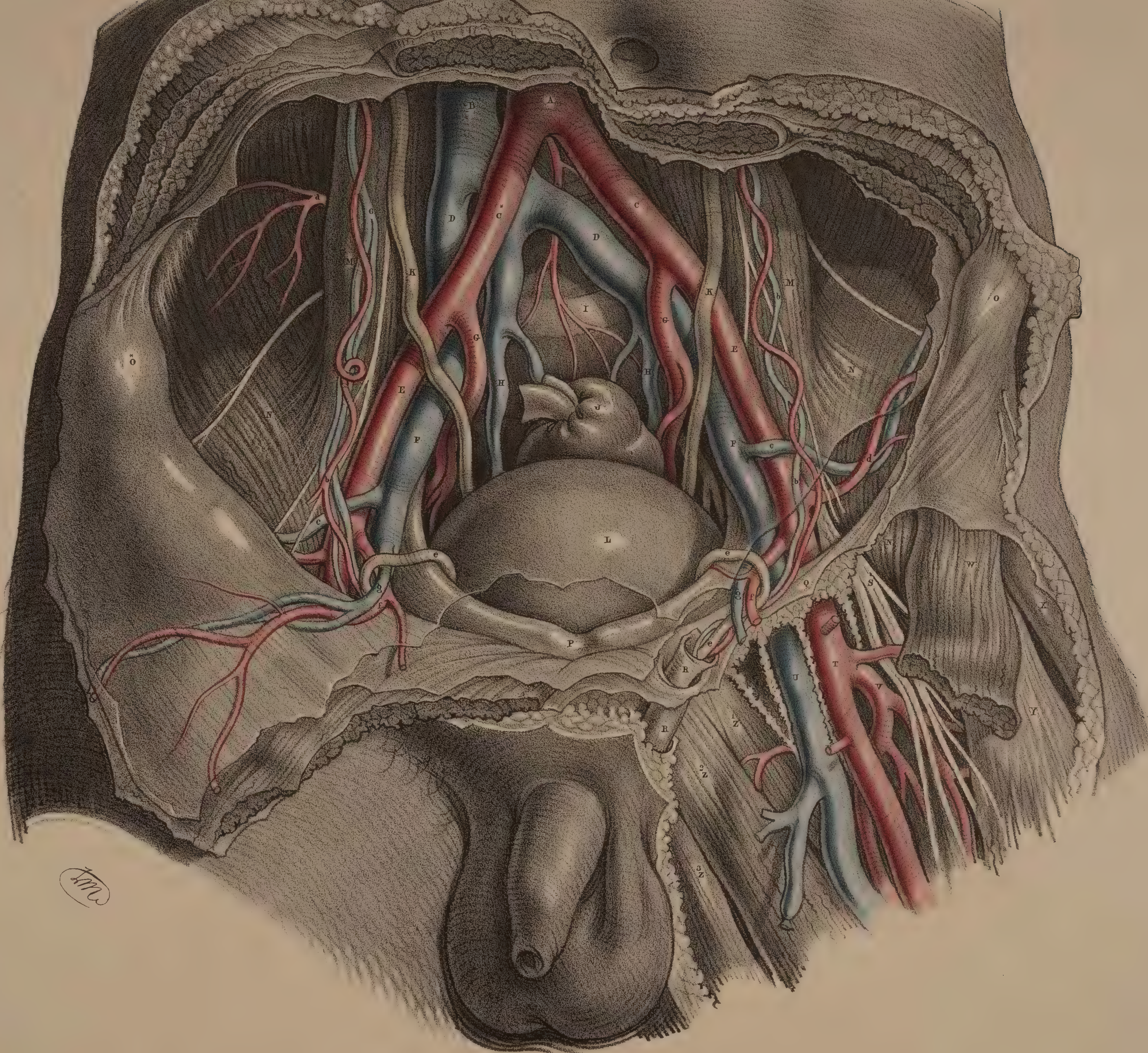
When an umbilical hernia is first formed at adult age, the bowel is usually to be found enclosed in a serous sac, extended from the peritonæum; but when the hernia has become inordinately enlarged, its sac in some parts of the periphery may be wanting, either from having been ruptured, or so attenuated that the contained viscus has become adherent to the subcutaneous tissue. The contents of this hernia may be either the transverse colon, a part of the ileum, or a part of the stomach. The passages of umbilical and other forms of ventral herniæ are generally so large that those protrusions are readily reducible by the taxis. When one of them is affected by strangulation, this, it would appear, is the consequence of a sudden increase of the contents taking place, without a corresponding enlargement of the hernial opening. The operation for the relief of such strangulation needs no particular anatomical notice. In whichever direction the incision of the constricting part be made, no vessel of any importance is liable to be wounded. Whatever be the size of the protrusion, it would seem as if there were no necessity of making the incision of the containing parts so large as to expose the whole of the contents. The neck of the sac can be readily reached in all cases without such means: wherever it may be judged proper to incise the border of the herniary opening, above, below, or on either side, a division of the integuments of an inch long will be found to answer for that end. But while the operation may be thus easily performed for the reduction of the herniary viscus, it is found very difficult to effect its permanent retention in the abdomen, unless by the constant use of mechanical appliances. This is in consequence of the herniary aperture being so large that its closure does not take place by an approximation and union of its callous borders, whereby further protrusion might be prevented, but by a thin layer of cellular substance or the like, insufficient to withstand the pressure from within of the bowel, which, from having been once herniary, has ever after a tendency to that occurrence.

The places where a hernia may occur, and form no apparent tumour externally, even though it be of somewhat large proportions, are the following:—1st, behind the iliac and femoral vessels; 2nd, between the bladder and rectum, or between the uterus and bladder, or the uterus and rectum, and pointing towards the perinæum; 3rd, between the bladder and vagina, and protruding into the latter, or descending aside of it into the labium pudendi, as in the case of inguinal hernia in the female;—between both these latter forms the distinction can be drawn by the absence or presence of a tumour at the external inguinal ring; 4th, through the obturator foramen, under the pectineus muscle—an occurrence very remarkable, considering the small size of that passage, and that it is occupied by the vessels and nerve; 5th, through the ischiatic notch, above or below the pyriformis muscle, and overlaid by the gluteus maximus; 6th, through the diaphragm into the thorax, as a consequence either of congenital deficiency in the muscle, or of a rupture of it from sudden inordinate compression of the viscera by abdominal action. While those herniæ cannot be detected by any outward or physical sign, and while the symptoms of strangulating obstruction are not different from those attending other pathological conditions, such as intus-susception &c., it is evident that not only are they not amenable to operative measures, but their existence cannot be ascertained with certainty.

Note.—In the descriptions of femoral hernia by several authors some obscurity prevails, in consequence of the same part being differently named, and different parts having the same name. The "upper cornu of the saphenous opening," the "falciform process" of Burns, and the "femoral ligament" of Hey, are names applied to the same structure. The portion of superficial fascia which masks the saphenous opening, and the inner side of the femoral canal, which is pierced by the femoral lymphatics and some small veins, are known as "cribriform." The "femoral arch" is Poupart's ligament; and though Gimbernat's ligament is but a small process of Poupart's, some are yet as unaccustomed (from the elaborate distinctive descriptions of those parts) to consider them as portions of the one structure, as they are to regard the *far-famed* Poupart and Gimbernat as having been one and the same individual. The sub-serous disc of cellular tissue, occluding the femoral ring, is the *septum crurale* of Cloquet; but Mr. Lawrence ("Treatise on Ruptures") denies the existence of that septum; and well he may; while Sir Astley Cooper, joining it with the sheath of the femoral canal, calls both the *fascia propria* of the hernia, which certainly is the best way of disposing of the septum, for, whether it exist or not, can matter very little anatomically or surgically.

The precise seat of stricture is a question much controverted by authors; but it is not easy to determine after all in what essential particular they differ, or can differ, seeing that the herniary opening is a *ring*, and, as such, must constrict by all its arcs, of which one alone (the inner one) admits of being safely divided. "The stricture," says Sir Astley Cooper ("Lectures on Surgery"), "is generally in the neck of the sheath; it is *not* situated at Gimbernat's ligament; it is *never* known to be there; it is at the crural arch, just where the intestine leaves the abdomen. Persons who think the stricture is at Gimbernat's ligament are grossly ignorant of its real seat." Mr. Lawrence (op. cit.) remarks, however, that "my own observations on the subject have led me to refer the cause of stricture to the thin posterior border (Gimbernat's ligament?) of the crural arch, at the part where it is connected to the falciform process." This statement agrees with the experience of Hey ("Practical Observations"), and with that of Liston, though differently expressed in his "Operative Surgery;" while Mr. Fergusson ("Practical Surgery") considers the seat of stricture as "almost invariably to be found in the crural ring;" that Gimbernat's ligament "is not more the seat of stricture than any other part of the ring." With this latter view of the fact, all who consider the form of the herniary opening must agree; but yet it cannot render Gimbernat's ligament less an object of particular interest in the operation, for this is the only part of the ring which, with a safe and the required effect, can be incised. In the following observation there is also much truth: "The seat of stricture is not the same in all cases, though, in by far the greater number of instances, the constriction is relieved by the division upwards and inwards of the falciform process of the fascia lata and the lunated edge of Gimbernat's ligament, where they join with each other. In some instances it will be the fibres of the deep crescentic (femoral) arch; in others, again, the neck of the sac itself, and produced by a thickening and contraction of the sub-serous and peritoneal membranes, where they lie within the circumference of the crural ring."—Morton, "Surgical Anatomy of the Groin," p. 148.

Regarding the fact of the obturator artery being exposed to injury in dividing the stricture, when that vessel is a branch of the epigastric, anatomists have not been sparing of their observations. Of the relative frequency of this origin of the obturator, M. Velpeau ("Médécine Opératoire") remarks, "L'examen que j'ai pu en faire sur plusieurs milliers de cadavres, ne me permet pas de dire qu'elle se rencontre une fois sur trois, ni sur cinq, ni même sur dix, mais bien seulement sur quinze à vingt." Monro ("Observations on Crural Hernia") states this condition of the artery to be as one in from twenty to thirty cases; Mr. Quain ("Anatomy of the Arteries"), that the proportion is as one in three and a half, which estimate agrees with that of Cloquet and Hesselbach. Sir A. Cooper never having met with an instance (in practice) of the vessel being on the inner side of the neck of the hernial sac, must show that this position of it is very rare. "What determines the position of the obturator artery with respect to the femoral ring?" is a question advanced by anatomists, but for the answer we need not search within the threshold of philosophy.



M & N Hanhart Imp^t

COMMENTARY ON PLATES XXXIX. XL. & XLI.

THE FORM OF THE PELVIS AND THE RELATIVE ANATOMY OF ITS VISCERA AND BLOODVESSELS, &c. MECHANISM OF THE PELVIC APPARATUS IN REFERENCE TO ITS CONTAINED ORGANS.

The pelvic segment of the body is composed of two sides, each of which is of so singular a shape that the most profound geometrician (if he had never seen the part) could form no true idea of it, however closely it was described; nor could he himself (taking it in hand) give it a name according to its likeness to any other figure—square, spherical, elliptical, rhomboid, or trapezoid; for it is a compound not only of them, but of all their modifications. This is the *innominate* bone, so called as defying description or definition;—a form of notches, foramina, crests, spines, tuberosities, and processes—an indecipherable enigma, considered *per se.* Yet this form is an example, when viewed in natural apposition with its counterpart, of how things of the most bizarre character conform, as sides, to represent a perfectly symmetrical whole. One innominate bone is exactly like the opposite one; and the pelvis, consisting of the two, exhibits complete symmetry; and is thus far intelligible. But, except for bilateral symmetry, the pelvis itself is a form indefinable: its name does not accord with it any more than the name ring suits the sphere. While, therefore, it is in vain that we look for a form, extraneous to the body, with which to compare the pelvis, so as to understand its signification and its mechanism, we have only to seek for it within the body, and compare Nature with herself.

When the abdomen is eviscerated, so as to expose the pelvic organs, I am at once struck with the fact that, through the groin to the thigh, as through the axilla to the arm, the principal bloodvessels and nerves are transmitted in a very similar manner. In the one place the main vessels, nominally divisible into axillary and brachial—and in the other into iliac and femoral, are continuous from their points of origin in the aorta to their termination in the limbs. Considering them in their continuity, we not only avoid the disadvantage (in a practical light) of treating any one part of them irrespective of the others (for facts of chief surgical importance may be overlooked in consequence of artificial boundaries obscuring them), but we discover them, under comparison, to be as clues leading to the true meaning of the two apparatuses with which they are respectively in connexion. In recognising the sum of the uniformity of the shoulder and pelvic apparatus, we at the same time identify the sum of the difference between both; and we note their differential features to be the result of a very simple modification of originally identical parts. In that modification the existing design reflects itself; description gains an increasing interest; and forms, hitherto unintelligible in the hands of the mere descriptive anatomist, and hence nameless for or misnamed by him, manifest to us their true signification, without knowing which we cannot understand aright and fully either the law of their creation or the mechanism of their combination.

The pelvis is as closely related to the abdomen as this is to the thorax. The two latter cannot be contemplated irrespective of each other, for their parts are common to the two, and their functions are correlative—mutually dependent. This anatomical and functional correlation is even more apparent between the pelvis and abdomen, for they are not separated even by a diaphragm. When we would ascertain the meaning and use of any part of the body, we must seek for them in its relative position. The thorax is superior to the abdomen, to act upon this compartment: the abdomen is superior to the pelvis, to subject this to its action: and consequently the action of the thorax is transmitted through the abdomen to the pelvis. The three compartments constitute the trunk; and therefore it is in their connexion and their relative position that we are to discover the signification of each. As between contiguous parts it is their apposition which gives them their meaning, so between remote parts it is in their serial and their symmetrical positing that their meaning is expressed. The vertebral column is common to the thorax, abdomen, and pelvis; and, notwithstanding the modification apparent between the forms of the several classes of the vertebræ, their serial arrangement indicates their common similitude. As with the units of the vertebral column in the posterior median line, so with those of the sternum in the anterior median line produced by the linea alba, through the abdomen to the pubic symphysis; and so likewise with the costal units laterally, figured serially in the abdomen by the lineæ transversæ, and succeeded in that order by the pubic and ischiadic bones. Comparing, then, the three compartments in respect to the components of each, we see that their *symmetry* depends upon the parts of one side of each being identical with and opposite to the parts of the other side; but besides symmetry, they invite us to another mode of comparison, that of *series*, in which they express a fuller meaning. In the thorax we notice the sterno-costo-vertebral circles, complete above and incomplete below, and according to the quantitive difference of those circles we see the form of the thorax to be struck, and that upon that form its function as a respiratory apparatus depends. In the abdomen we notice the costo-sternal pieces to be absent as bone, but present as fibrous parts; while the vertebral elements alone persist as bone, and compared with the thorax we see the difference between both, and that the abdomen is functional by reason of the absence of the costo-sternal pieces; but still, in idea we cannot but encircle abdominal space as costal, for in fact the parts which are absent as bone here, are the same as the parts which are present as bone elsewhere; and so the cause and manner of the design of abdominal form must be evidently in the subtraction of those parts, even if that form did not appear, in certain of the lower animals, still costal, like a thorax. It is by this serial comparison that the pelvis reveals its signification, the law of its formation, and the peculiarity of its construction.

The elemental parts of which the pelvis is formed arrange themselves into three groups as naturally differing from each other (though they be united) as the sternal, the costal, and the vertebral elements appear. From the sacrum, posterior and central, the two ossa innominata arch laterally, and meet to form the pubic symphysis, anterior and central; but though each of the latter bones appears at adult age one and indivisible normally, it is not the less to be regarded as a compound bone, than is the form composed of the sacrum and it, united abnormally by anchylosis. The sacral elements are a group in series with and homologous to the vertebral elements, and to no other: the pubic and ischiadic pieces (separable from the iliac bone in early life) are in series with the anterior costal pieces of the thorax, and are identical with these, and with no other than these. The iliac bone is *not* in natural series with any of the thoracic pieces; cannot be likened to any one of them; and is therefore a totally different part from any other appearing in either the thorax or the abdomen. The true homologue of the ilium is evidently the scapula; and to see this we have to separate the ilium from the sacrum, the ischium, and the pubic bone, when now the ilium and scapula will be found to correspond not only in general form, but in their mode of development; the relation which their respective groups of muscles have to them; and also as regards the neighbouring vessels and nerves.

FIGURES OF PLATE XXXIX.

A, The abdominal aorta at its bifurcation.—B, Commencement of inferior vena cava.—C C*, Right and left common iliac arteries.—D D, Right and left common iliac veins.—E E, Right and left external iliac arteries.—F F, Right and left external iliac veins.—G G, Right and left internal iliac arteries.—H H, Right and left internal iliac veins.—I, Lumbo-sacral promontory.—J, Rectum intestinum.—K K, Right and left ureters.—L, Urinary bladder.—M M, Psoas muscles.—N N, Iliac muscles.—O O*, Iliac spinous processes.—P, Symphysis pubis.—Q, Poupart's ligament.—R R, Spermatic cord passing through external inguinal ring.—S, Anterior crural nerve.—T, Femoral artery.—U, Femoral vein.—V, Profunda artery.—W, Sartorius muscle.—X, Tensor vaginæ femoris muscle.—Y, Rectus femoris muscle.—Z 1, Pectineus muscle; Z 2, Adductor longus muscle; Z 3, Gracilis muscle—a, Ilio-lumbar artery; b b b b, Spermatic vessels; c d, Circumflex iliac vessels; e e, Vasa deferentia; f, g, Epigastric vessels.

When I place the ilium and the scapula of the same side together, so that their corresponding parts are in apposition, they resemble each other as well in their general figure as by their surfaces, borders, notches, angles, and processes. The posterior border or base of the scapula corresponds, then, with the upper border or crest of the ilium; and we know that both parts are developed from distinct centres, forming epiphyses, which afterwards coalesce with the body of the bone. The anterior superior spinous process of the ilium represents then the posterior superior angle of the scapula, neither of which parts is formed of a separate primary piece. The remaining parts of the two bones also correspond: the posterior inferior angle of the scapula being developed from a distinct nucleus, like the posterior spinous process of the ilium, which joins the sacrum, represent each other: the coracoid process of the scapula answers to the anterior inferior spinous process of the ilium, both those parts being developed from separate centres of ossification: the superior and inferior costæ of the scapula are not developed as separate borders of that bone, neither are the corresponding anterior and posterior borders of the ilium separately developed. In no part of the ilium, however, does there appear a process corresponding to the spine and acromion of the scapula; but this cannot despoil the two bones of their analogy, else a scapula is not a scapula among the lower species of animals, while we find it in one species with that process and spine, and in another without either. Sufficient, then, being the sameness of both bones to induce us to compare them, and regard them as homologues, we can at once, while viewing them in their natural respective positions, define, so far, the difference between the shoulder and the pelvic apparatus: the ilium is intercalated between the sacrum behind, and the pubic and ischiadic bones in front; and, according to the space which it occupies between those bones, are the ribs annihilated, as being useless. In this position, regarding the ilium comparatively with the scapula, and calling the same parts of each by the same name, we see the base (crest) turned upward, as the hip; the superior costa (anterior iliac border) turned forward, forming, with the os pubis, the ilio-pubic notch, spanned by the femoral arch; the inferior costa (posterior iliac border), turned backward, forming the sciatic notch; the glenoid fossa (acetabular facet), turned downwards vertically on the head of the femur; while the posterior inferior angle (posterior iliac spinous process) becomes applied to the sacrum as the sacro-sciatic junction. Thus the difference between a scapula and an ilium is chiefly owing to their position and mode of connexion with other bones, and as a consequence they, in forming their junctions with the neighbouring bones, render the shoulder and pelvic apparatuses what they are as specialties. The scapula is movable on the thoracic ribs between the dorsal vertebræ and sternum, and is borne outwards by the costiform clavicle, with which it articulates; the ilium, having a position inverted, compared with the scapula, is fixed between the vertebral sacrum and the costiform pubic and ischiadic bones, and separates those elements which are naturally related as segments of costo-vertebral circles; the place of those costal parts which would have connected them being occupied by the ilium. That this is the signification of the mode in which the pelvis is constructed—as a basis of union between the trunk and lower extremities for locomotion—as a basis of support to the abdominal viscera, and as a recipient for its own—is further indicated by the relative position of its muscles, and the distribution of its vessels and nerves.

The visceral surface of the ilium (venter of the scapula) has resting upon it the iliacus muscle. This muscle resembles the subscapularis in form, position, and attachments. The iliacus arises from the inner margin of the crest of the ilium, and from the whole ventral surface of that bone; and the fibres of it converging towards the outer part of the ilio-pubic notch, traverse this place, and thence turn backwards and downwards to be inserted into the lesser trochanter on the inner side of the head of the femur. The subscapularis arising in the same way from nearly the whole of the venter of the scapula, appears with its fibres converging towards the inner side of the head of the humerus, and becomes inserted into the lesser tuberosity of that bone. The psoas muscle appears as the counterpart of the teres major by its place and attachments. The psoas, in addition to its origin from the sides of the lumbar vertebræ, has one also from the posterior spinous process of the ilium, and, between the latter point and the ilio-pubic notch, it lies along the posterior margin (brim of the pelvis) of the iliac bone, and sidelong with the lower border of the iliacus; and its fibres ending in a tendon common to the two muscles have the same point of insertion—the lesser trochanter of the femur. The teres major arises from the posterior inferior angle of the scapula, lies along the inferior costa of that bone, and is inserted into the humerus close to its lesser tuberosity. But the psoas and iliacus muscles are covered by the peritonæum, while the thoracic ribs separate the subscapularis and teres major from the pleura; this difference is, however, to be accounted for in the foregoing remarks upon the fact that the iliac bone takes the place of those costal parts which would otherwise have joined the costiform os pubis and ischium with the lateral masses of the sacral vertebræ (those masses being evidently the stunted analogues of ribs which form with the ilium the sacro-iliac junction), and thus comes, with the muscles on its venter, into apposition with the abdominal serous membrane. When we compare the muscles on the dorsum of the ilium with those on the dorsum of the scapula, their analogy, in respect to relative position, number, and attachments, is also evident. The gluteus maximus arises from the posterior third of the crista ilii, and is inserted into the great trochanter of the femur just as the infra-spinatus muscle of the scapula arises from the lower half of the base and dorsum of that bone, and is inserted into the greater tuberosity of the humerus. The gluteus medius arises from the middle and anterior parts of the crest and dorsum of the iliac bone, and is inserted into the great trochanter of the femur in the same manner as the supra-spinatus muscle of the scapula arises from the upper half of the base and dorsal surface of that bone, and is inserted into the great tuberosity of the humerus. The gluteus minimus muscle arises from the dorsal surface of the ilium above the acetabulum, and is inserted as the other glutei; and so is the teres minor muscle, arising from the dorsal surface of the scapula, near the glenoid fossa, inserted with the supra- and infra-spinati. Between those dorsal muscles of the ilium and those of the scapula, the principal difference is owing to the absence of a part on the former bone which would correspond to the spine and acromial process of the latter. On the scapula, this process serves, with other uses, to separate the muscles; on the ilium, its absence causes them to come into contact, and necessarily to overlie each other in some degree. The analogy between the rectus femoris, arising by one head from the anterior inferior iliac spinous process, and by another from the upper margin of the acetabulum—and the biceps humeri, arising from the coracoid process by one head, and from the upper margin of the glenoid fossa by another, completes what it is necessary to remark in demonstration of the correctness of the present views so far as regards the muscles.

The bloodvessels traversing the iliac region to the thigh, correspond with those traversing the root of the neck and axilla to the arm, in their general relations; and in the manner in which they distribute their branches in reference to the bones, they tell of the corresponding parts of these as above-mentioned. The abdominal aorta, on the body of the fourth lumbar vertebra, on a level with the navel in front, and the highest parts of the cristæ iliorum laterally, bifurcates into the two iliac branches symmetrically; and these diverge from each other in their passage to the middle of each groin, and are thence produced in the same direction to the middle of each thigh. In this course each vessel may be regarded as a main trunk, giving off at intervals large branches for the supply of the pelvic organs, the abdominal parietes, and the thigh. As the axillary artery is directed towards the head of the humerus, so the iliac artery takes the direction of the head of the femur. Between its point of origin in the aorta and the sacro-iliac junction, where it gives off its internal iliac branch, the main artery (corresponding with the innominate) is named *common iliac*—a part of the vessel which is very variable as to its length, however, but which is stated to be usually about two inches. On tracing the internal iliac artery into the pelvis, the first branch of this vessel will be observed to pass outwards through the greater sciatic notch, and to wind over the dorsum ilii between the gluteus medius and minimus muscles, in the direction of the hip joint; this branch, (the gluteal,) has a course similar to a branch of the subscapular artery, which ramifies on the dorsum scapulæ, beneath the muscles covering that part of the bone. The other branches of the internal iliac are arranged like the thoracic branches of the axillary artery. From the origin of the internal iliac branch to the place where the main artery emerges to the thigh, beneath the femoral arch, the vessel (corresponding with the axillary) is named *external iliac*. This portion of the vessel follows the inner margin of the psoas muscle, overlapping the brim of the pelvis, and in general gives off no important branches except at its lower end, where the epigastric and the circumflex iliac arise from it, and course as their names indicate. Their origins from the parent vessel are not unfrequently as high as its middle, in which case the surgical length of it may be regarded as short. When the external iliac artery becomes femoral (as the axillary artery becomes brachial), it gives off the profundus branch to supply the muscles and other parts of the thigh. This branch generally arises at about an inch and a half or two inches below the fold of the groin, and between it and the epigastric branch above, the main artery is named *common femoral*. Below the profundus branch, as far as the popliteal space, the femoral

Fig. 1.

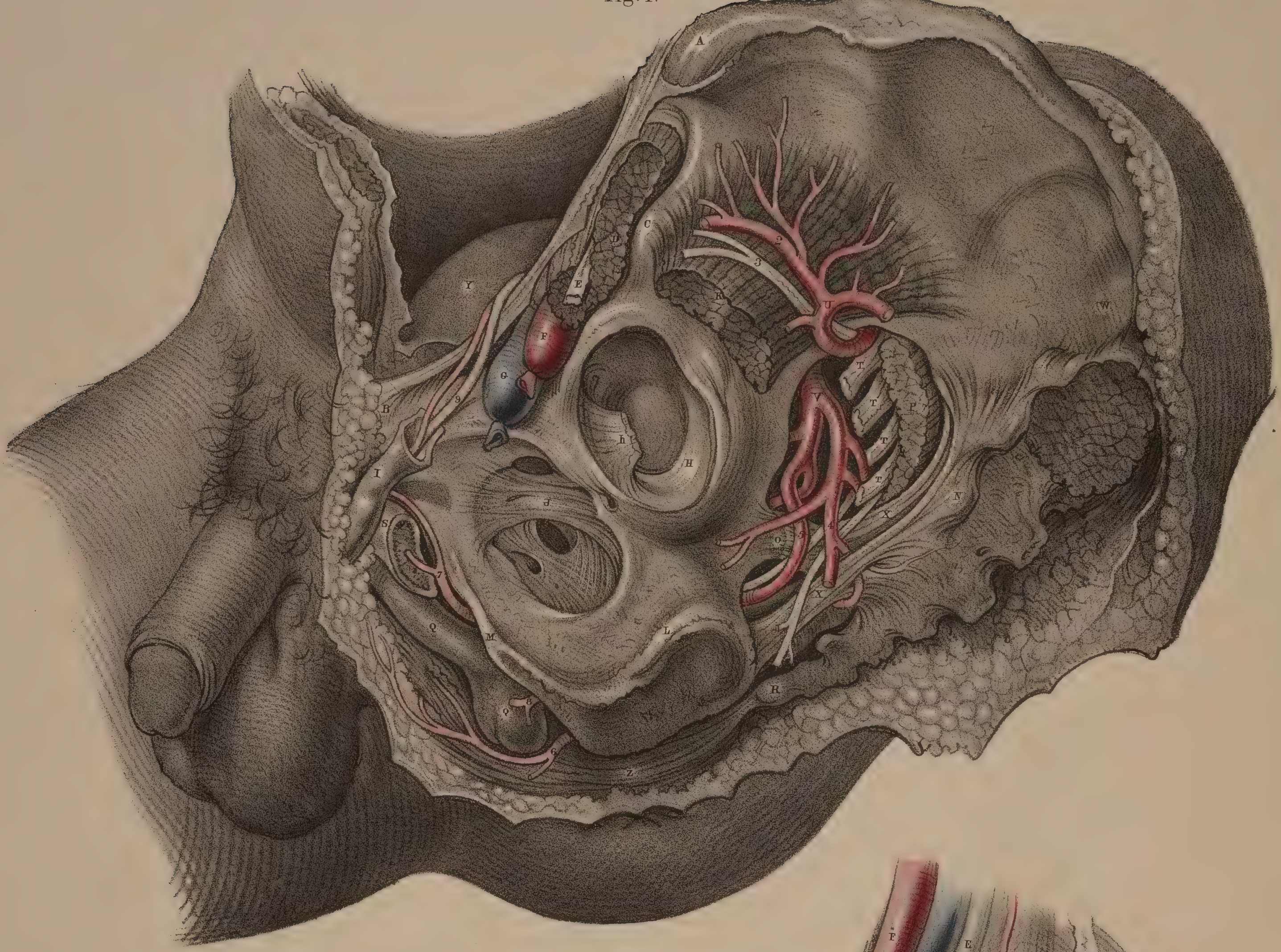
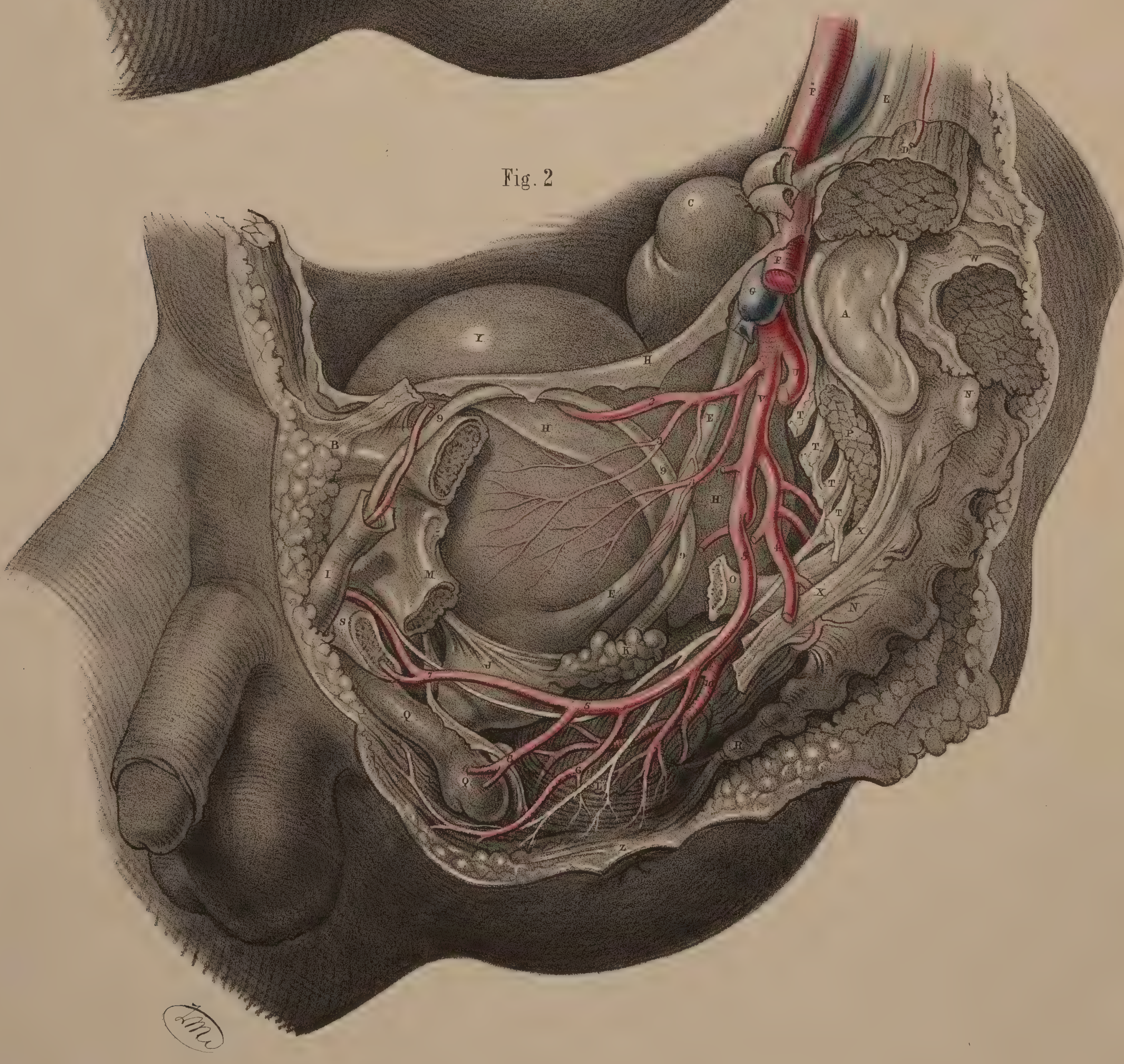


Fig. 2



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artery appears as an undivided trunk, being destined to supply the leg. In this course the artery is accompanied by the vein, which is also ideally subdivided according to the region it traverses. The external iliac artery, with its femoral prolongation, has the accompanying vein on its inner side. Above the femoral arch both vessels are invested by the peritonæum, and under the small intestine; they are also bound in their place by a thin process of the iliac fascia, and some lymphatic bodies here overlie them. The ureter, descending on the psoas muscle, passes over the origin of the external iliac vessels to the bladder, in the pelvis; while the spermatic artery and vein, with the genito-crural nerve, also descending on that muscle outside the iliac vessels as far as the femoral arch, here pass inwards over them to loop around the epigastric artery, in doing which they are joined by the vas deferens, rising at the side of the bladder from the pelvis, and with this duct enter the inguinal canal through the internal inguinal ring. The profundus branch of the femoral artery is the representative of the superior profundus branch of the brachial artery, the position of the former in respect to the head of the femur and its mode of distribution in the thigh, being similar to that of the latter in respect to the head of the humerus and its distribution in the arm. Below the profundus branch of the femoral artery, this vessel, like the brachial, is a main trunk as far as the next joint.

The elemental parts of the pelvic apparatus having been now noticed as similar to those existing elsewhere in the body, and the analogy between the parts of it and those of the shoulder apparatus being fully discernible, the difference as to the form of both apparatuses gives the difference as to the design and uses which they respectively serve. In the form of the pelvis, however described, we can mark its adaptation to its uses; but while we know that that particular form results by a special mode of coaptation of its parts, which parts are represented elsewhere in a somewhat different relation to each other, and yield a different design, at the same time that analogy is traceable between the parts of both, and between both as entireties, then not only can we read the design of each, but we can trace the manipulation, as it were, of an artificer. Considering the pelvis under this point of view, we acknowledge the uses of its notches, foramina, processes, &c.; but while we know that these must of necessity result as a consequence of the existing coaptation of elemental parts, each of which has a definite shape, and cannot assume that of any other, or yield a pelvis of any other kind of conformation than what it presents, any more than can multiform crystals arranged in a certain fixed relation to each other,—then, in addition to appreciating its design, we have the interest of analysing its form as thus: 1st. The pelvis appears as an osseous cincture appended to the sacral part of the vertebral column, and encircling space like a thorax. Between the sterno-costo-vertebral thoracic series and the pelvis a hiatus, in regard to *osseous* sternum and ribs, occurs; and that hiatus is the abdomen. The absence of ribs and sternum is essential to abdominal form; and upon this also depends the capability of the trunk to perform its various flexures by means of the lumbar spine, which allows the pelvis to alter its axis in regard to, or to render it coincident with, those of the thorax and abdomen. 2nd. Viewed in front, the vertical measurement of the pelvis is much less here than laterally or posteriorly, for the same purpose. In the median line in front appears the pubic symphysis, or junction of the pubic bones, meeting like two of the sternal ribs, with which they are in series, and placed, like these, horizontally. Below the pubic symphysis, as a necessary result of that form, appears an arched space for the genito-urinary passages, and bounded on either side by the ascending rami of the ischiadic bones joining the pubic, and resembling that space which intervenes between the eighth and ninth pairs of opposite ribs below the sternum. 3rd. On either side of the pubic symphysis, and between the rami of the pubic and ischiadic bones, appears an interval—the thyroid aperture, like the interval between two sternal ribs, and in the same manner occupied by two layers of muscular and ligamentous structure, and transmitting an artery and nerve, which, as they are in series with the intercostal arteries and nerves, signify that the aperture is as if intercostal. 4th. Immediately external to the thyroid aperture is the acetabulum, formed by the junction of the articular end of the ilium with the pubic and ischiadic bones, and seeming as if a scapula united its glenoid facet by anchylosis with the outer ends of two sternal ribs; in which case the shoulder apparatus would lose in needful mobility as much as the pelvic apparatus would lose in needful fixity, if its parts assumed a mode of connexion like that of the shoulder-bones as normally appearing. 5th. Below the acetabulum appears the tuber ischii, which, with its fellow of the opposite side, bounds the pelvic outlet laterally, each tuber seeming to me to be the result of a bend in the costiform ischium, of which the posterior part turns upwards to join the ilium in the acetabulum, while the anterior part forms a side of the pubic arch; and from that bend the bone (quod sustineat sedentem) derives its name, and the interval between it and the os pubis is thyroid. 6th. From the acetabulum of each side rises the iliac bone, placed, as before noticed, like a scapula, with its base (crest) upwards, joining the lateral masses of the sacrum by its posterior angle, and occasioning thereby the sacro-sciatic interval, as between the inferior costa of a scapula and the vertebræ. It so happens by this position that the strongest part of the ilium (the triangular prismatic column, the corresponding part to which, in the scapula, is also the strongest and prismatic) is that by which it abuts against the sacrum; and thus the bone is enabled to resist more effectually the shocks transmitted through it by the superincumbent weight to the supporting head of the femur. The iliac bones, placed thus at right angles to the horizontal pubic rami, occasion that wide depression in the pelvic front, which, limited above by a transverse line drawn from the anterior superior iliac spinous process of one side to the other, includes the inguinal and hypogastric regions. Among other uses of this position of the ossa ilii, two are most obvious, namely, that of serving as an effective lever for muscular action, and as a resisting floor for the movable abdominal organs, which, under pressure, tend to glide from its incline and concentrate the force in reference to the pelvic viscera. 7th. Occupying the middle line, and forming the posterior wall of the pelvis, is the sacrum, a form evidently of vertebral character, and consisting of five (less or more) vertebræ, anchylosed so as to answer as a solid wedge between the ilia, and as a transmitter of gravitating force. Considering the sacrum as composed of vertebræ, it represents in shape a decreasing series of those bones, that is to say, a quantitive degradation of them, like 9, 8, 7, 6, 5, 4, 3, 2, 1; and thus, it appears, terminating in a *quasi*-caudal appendage, converted in the human form to other uses than those of the corresponding part in the lower species of animals. The sacro-coccygeal form is altogether pelvic in man. From each of its lateral borders arise two strong bands of ligament, one of which is attached to the spine of the ischium, and the other to the tuberosity of that bone, and the two dividing the sacro-sciatic interval into two spaces of unequal areas,—viz., the superior greater and the inferior lesser sacro-sciatic foramen, are evidently intended to maintain the forward curve of the sacro-coccygeal form where, tapering, it becomes weakened. While thus, by its comparison with the shoulder apparatus, we reveal the signification of the pelvis, of its asperities, its prominences, its interosseal intervals, and its general form, we are the better enabled to estimate its mechanical design as equally fitting for its several uses. On this subject it remains to add a few observations to those already given.

In the erect posture, the pelvis is so situated in reference to the abdomen, that while the axis of the latter is vertical between the middle of the diaphragm and the pubic symphysis, that of the former is oblique between the umbilicus in front and the point of the coccyx behind and below. Both axes, therefore, cross in the abdomen, behind the hypogastrium, but by the anterior flexure of the lumbar spine they may be made to correspond, and this is the attitude naturally assumed for giving effect to abdominal action in reference to the pelvic organs. The pelvis has two axes, of which one would be represented by a perpendicular passing through the centre of the plane of its brim or inlet, and produced backwards and downwards to the point of the coccyx, while the other would be indicated by a right line passing from the middle of the sacrum through the middle of the lower third of the pubic arch. Both the pelvic axes may be said, there-

FIGURES OF PLATE XL.

Fig. 1.—A, Iliac anterior superior spinous process.—B, Spinous process of pubes.—C, Iliac anterior inferior spinous process.—D, Psoas and iliacus muscles, cut.—E, Anterior crural nerve, cut.—F, Femoral artery, cut.—G, Femoral vein, cut.—H, Acetabulum; h, ligamentum teres, cut.—I, Spermatic cord.—J, Fibrous bands crossing obturator foramen. —K. Gluteus minimus muscle, cut.—L, Tuber ischii.—M, Ascending pubic ramus of ischium.—N, Sacrum.—O, Spinous process of ischium.—P, Pyriformis muscle, cut.—Q Q, Urethra and its bulb.—R, End of coccyx.—S, Crus penis, cut.—T T T T, Sacral plexus of spinal nerves.—U, Gluteal artery.—V, Common trunk of pudic and sciatic arteries.—W, Posterior iliac spinous process.—X X, Sacro-sciatic ligaments.—Y, Urinary bladder.—Z, Sphincter ani muscle.—2, 3, Gluteal artery and nerve.—4, Sciatic artery.—5, Pudic artery.—6, Superficial perinæal artery.—7, Dorsal artery of penis, and artery of its crus.—8, Artery of the bulb.—9, Vas deferens.

Fig. 2.—The other parts are marked as in fig. 1.—A, Sacral facet of sacro-iliac junction. —C, Rectum intestinum.—D. Psoas muscle, cut.—E, Ureter.—H H H, Recto-vesical pouch of peritonæum.—J, Prostate gland suspended by anterior true ligaments.—K, Vesicula seminalis.—L, Lower end of rectum.—W, Lumbar mass of muscles, cut.—2, Remains of hypogastic artery.—3 3, Vesical arteries.—9 9 9, Vas deferens.

fore, to cross at the centre of the pelvic cavity. In respect to the pelvis in all its positions, its two axes may be considered as unalterable; but in regard to that of the abdomen, they may vary according to the flexure of the lumbar spine. The brim of the pelvis approaches in form that of a circle. All its diameters are less than those of the pelvic cavity; but the greatest difference between the two parts is observable in the antero-posterior measurement, and this is owing to the convex or backward curve of the sacrum. By the form of the sacrum the pelvis gains capacity as a recipient for its organs; and the curve of that bone, continued forwards and downwards by the coccyx, has evidently a reference to the pubic arch, which latter, while the perinæum remains as in the natural state, represents the only pelvic outlet that naturally exists; and, as such, we find the genito-urinary orifices occupying its axis, while the anal orifice appears at its base, midway between the tuberosities of the ischia. With regard to the sexual peculiarities of the pelvis, it needs only to be observed here generally, that the female pelvis is of relatively greater proportions in all its horizontal measurements, and of lesser proportions in its vertical measurements than those of the male, showing, in the conformation of the former, a provision for easeful parturition.

The relative anatomy of the pelvic organs is easy to be learnt, they are so few in number. The urinary bladder (in the adult) occupies the "true" pelvis when the organ is collapsed or only partially distended. It is, then, situated immediately behind the pubes and sub-pubic space, and (in the male) has the rectum descending close behind it, and taking the curve of the sacrum. Laterally, the bladder is in contact with the sides of the pelvic cavity; and inferiorly, it rests on the lower third of the rectum, and upon a movable floor, formed by the levator ani muscle, which is concave to receive it. The bladder varies much in shape, according to whether it be empty, semi-distended, or full; and its relations to neighbouring parts, especially to those in connexion with its summit, vary also considerably. When empty, the back and upper part of the organ are collapsed against its forepart, and in this state it lies flattened and corrugated against the front wall of the pelvis, and with the small intestine descended after it. Whether distended or collapsed, the small intestines lie upon its upper surface, and behind this part, and constantly compress it in the manner of a soft elastic cushion, especially in the erect posture. When largely distended its summit is raised for an inch or two above the level of the symphysis pubis; and the small intestines then having yielded place to it, we can distinctly feel it at the hypogastrium. This is the situation which it occupies in the fœtus, with its pointed summit immediately behind the umbilicus, and thence it gradually sinks into the pelvis in the advance of age, and according to the development and increasing capacity of this recipient.

In shape, the bladder varies in different individuals. In some it is rounded, in others pyriform, in others peaked remarkably at its summit. In capacity, it varies also considerably at different ages and in different sexes. In the aged it is relatively more capacious than in the young, but this is principally owing to some cause of obstruction in the urinary passages—an enlargement of the prostate, so common in advanced life. The greater relative width of the female pelvis than of the male implies a greater relative capacity of the female bladder. When distended, its long axis (in the adult) will be found to agree with a perpendicular to the plane of the brim of the pelvis—with a line passing from the navel to the point of the coccyx, the obliquity of the organ being greatest in the erect posture, for then the intestines gravitate upon its upper back part. But when the body is recumbent, the bladder recedes somewhat from the pubes; and as the intestines do not now press upon it from above, it allows of being distended to a much greater degree without causing uneasiness and a desire to void its contents. The manner in which the organ is connected to neighbouring parts is such as to admit of its free distension. Its summit, back, and the upper parts of its sides are free, and covered by the elastic peritonæum, whilst its front, its base, and the lower parts of its sides are adherent to the adjacent pelvic walls, and divested of the serous membrane. This will be best seen by removing the os innominatum, together with the lateral half of the levator ani muscle, which intervenes between the ischiadic part of that bone to which it is attached and the side of the bladder.

The pelvic organs being now exposed laterally, we find, on tracing the peritonæum from the hypogastrium to the point of its reflexion (immediately above the pubic symphysis) over the summit of the bladder, that membrane to be so loosely adherent to the organ, that this, when being fully distended, can raise the peritonæum somewhat above the upper margin of the pubic symphysis, and that in this state the bladder admits of being punctured here without wounding the serous sac. When the bladder is collapsed, the peritonæum follows its summit below the level of the upper margin of the pubes, and in this condition such an operation could not safely be performed; but now that proceeding cannot be required. After investing the upper part of the bladder, the peritonæum descends, adhering to its posterior surface as low as its base, and here becomes reflected from it backwards to the forepart of the rectum, bracing this organ to the sacrum. This duplicature of the serous membrane is the recto-vesical pouch, and it is required to note the level to which it descends, so as to avoid wounding it in the operation of puncturing the bladder through the rectum. The pouch passes lower in some bodies than in others, but always there exists a space of greater or less dimensions between it and the prostate, whereat the base of the bladder is directly adherent to the rectum. When we trace the peritonæum from one iliac fossa to the other, we find it behind the bladder, forming the sides of the recto-vesical pouch; but on tracing it over the summit of the bladder, it is seen to be reflected to this organ immediately below the pelvic brim, under the external iliac vessels. At the situations where the membrane is reflected, in front, laterally, and behind, to the bladder, it is thrown into folds named the "false ligaments" of that organ. Under the peritonæum, the pelvic fascia (which is an extension of the transversalis fascia) is reflected from the parietes to the bladder in a similar way, but at a lower level than the peritonæum; and, being thrown into similar folds, forms for the organ in front, laterally, and behind, the "true ligaments." In addition to those ligaments which serve to keep the base and front of the bladder fixed to the pelvis, other structures (the ureters descending from the lumbar regions to enter the side of the organ near the prostate, the vasa deferentia descending from the internal inguinal ring to enter it at the base of the prostate, and the hypogastric cords and bloodvessels passing from the internal iliac vessels behind, along the side of it, to their respective destinations) embrace it in various directions, and act as bridles, limiting its expansion more or less at all points, but least so towards its summit, which is always comparatively free. The neck and outlet of the bladder are situated at the anterior part of its base, and point midway at the sub-pubic space. The prostate gland surrounds its neck, and rests on the forepart of the lower end of the rectum, where, being of a rounded form and dense structure, it can be felt through the bowel. Those parts shall be more fully noticed hereafter.

The rectum, occupying the posterior middle line of the pelvis, is (in the male) between the bladder and the sacrum, and conforms with the curve of that bone by its middle and upper parts, which are invested by the peritonæum. The lower third of the bowel, not being covered by that membrane, is the part on which surgical operations can be performed. When the bladder is largely distended, it compresses, by its convex posterior side, the rectum against the sacrum, and causes the curve of the bowel to be greater than when the bladder is empty. This fact requires to be borne in mind when it becomes necessary to pass instruments or injections into the bowel, for this organ will receive them with more freedom if the bladder have been previously evacuated. The coccyx, continuing forwards the curve of the sacrum, bears the lower part of the rectum against the posterior half of the base of the bladder, and gives to this part a degree of obliquity upwards and backwards in respect to the perinæum and anus, which circumstance should be remembered in the operation of lithotomy. From the point where the base of the prostate lies in contact with the rectum, this latter curves downwards and slightly backwards, and terminates in the anus midway between the tuberosities of the ischia. The prostate is placed at about an inch and a half (in some two inches) higher than the anus, and anterior to it; but this measurement varies according to whether the bladder and bowel be distended or not, and also especially according to whether the prostate be enlarged or not.

The bloodvessels of the pelvic organs are derived principally from the internal iliac artery, which descends into the pelvis from its origin in the common iliac at the sacro-iliac junction; their nerves are from the hypogastric plexus of the sympathetic system. The rectum is chiefly supplied by the inferior mesenteric artery, which, arising from the forepart of the aorta above its bifurcation, branches upwards in the left meso-colon, and gives downwards a large branch to the rectum, ramifying on this organ as far as the anus. The *first* branch of the internal iliac is the glûteal artery, which, passing (with the gluteal nerve derived from the sacral plexus of the cerebro-spinal system) through the great sciatic foramen, between the bone and the pyriformis muscle, turns upwards on the dorsum of the ilium, and ramifies to the muscles there situated. The *second* branch is the obturator artery, which (accompanied by the obturator nerve from the sacral plexus) passes along the side of the pelvis a little below its brim, and is transmitted through the outer angle of the obturator foramen to the adductor muscles of the thigh.

Fig 1.

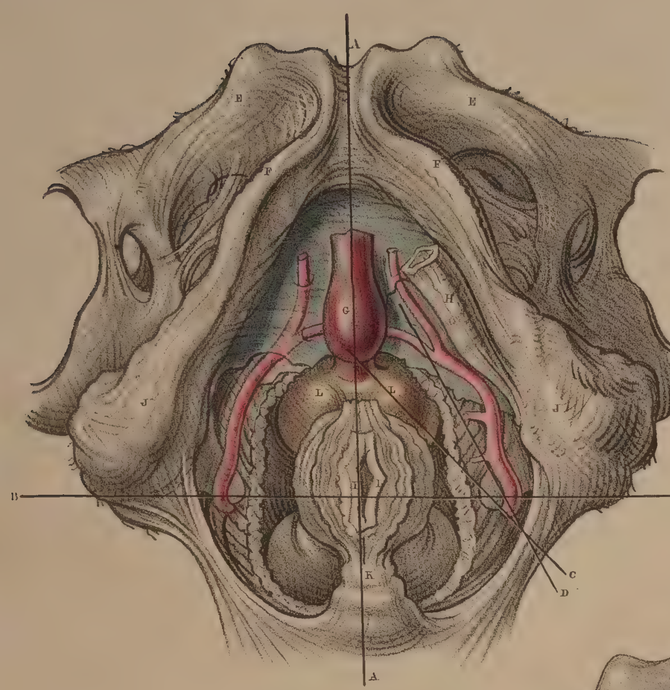

Fig. 2.

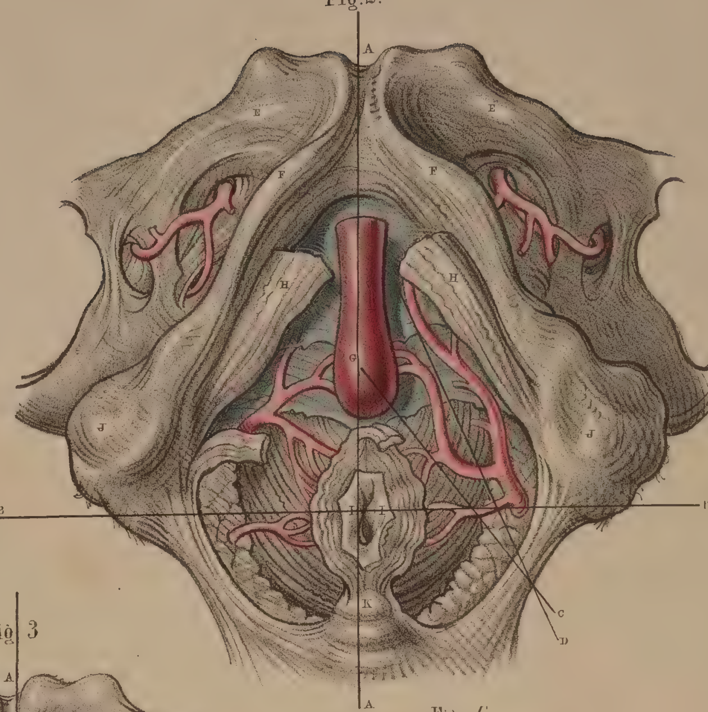

Fig 3

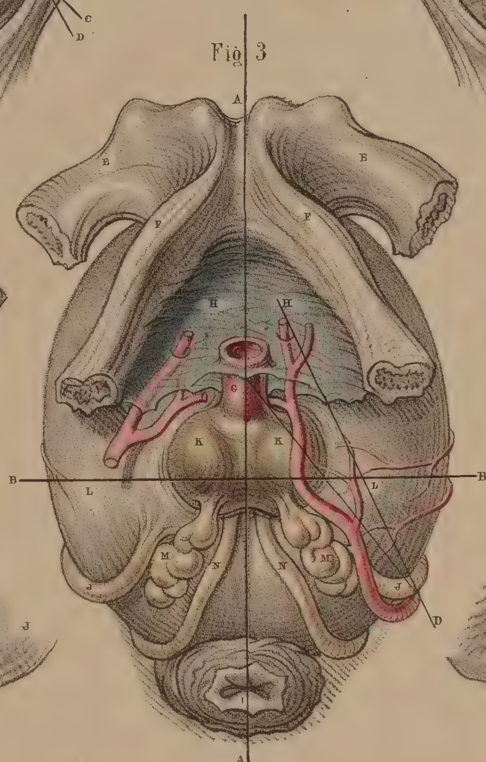

Fig. 4.

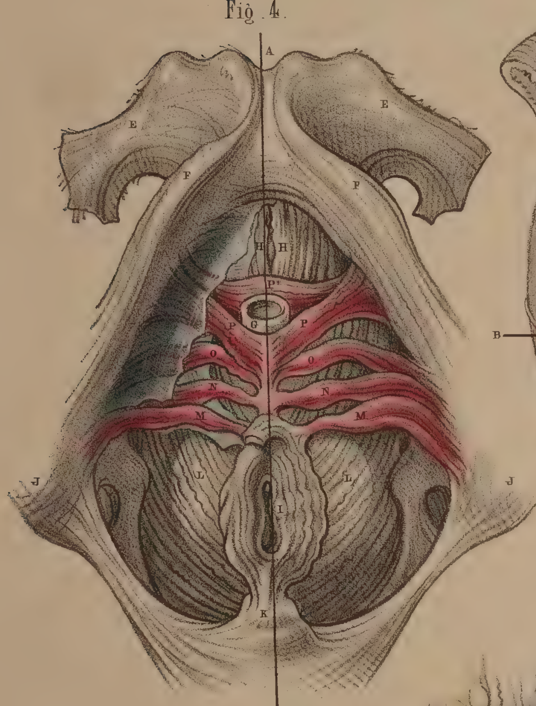

Fig. 5.

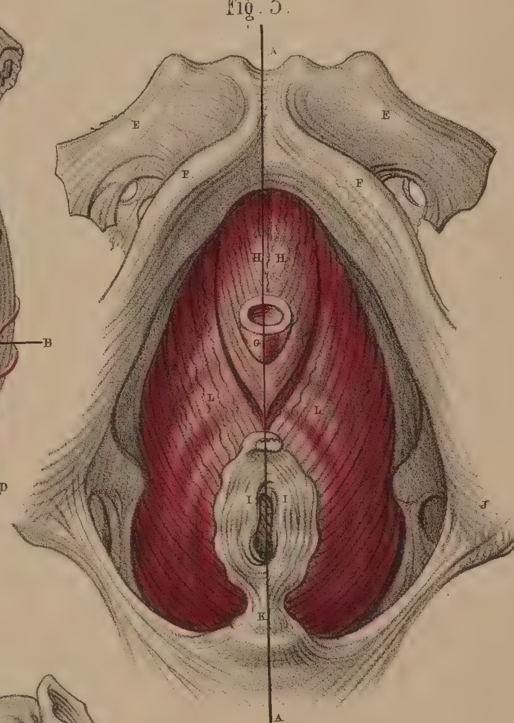

Fig. 6.

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The *third* branch is the remains of the hypogastric artery, which, pervious still for about an inch from its origin, gives off two or more of the small vesical arteries ramifying on the side of the bladder. The *fourth* branch is the sciatic artery, transmitted (with its accompanying nerve from the sacral plexus) through the great sciatic foramen, below the pyriformis, to the upper and back part of the thigh. The *fifth* is the pudic artery, appearing as the continuation of the internal iliac, and passing through the greater sciatic foramen, below the pyriformis, with the pudic nerve, derived also from the sacral plexus, winds with it around the spine of the ischium, and re-enters the pelvis by the small sciatic foramen, where the two, becoming braced to the inner surface of the ischium (about an inch and a half above its tuberosity) by a dense

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FIGURES OF PLATE XLI.

Demonstrations of the Relative Anatomy of the Base of the Male Bladder, the Urethra, and its other Appendages.

Fig. 1 represents the normal relations of the more important parts in connexion with the base of the bladder. The median line, A, drawn from the symphysis pubis to the point of the coccyx, K, is seen to traverse the centres of the urethra and its bulb, G, the prostate, L, the base of the bladder, the anus, I, and the rectum. If an incision were made according to that line, it would equally bisect each of those parts. These several structures are situated at different depths from the perinæal surface, and have therefore different relations to the base of the bladder. The bulb of the urethra is immediately in front of the anus, and both parts are comparatively superficial. The prostate is between them, and on a plane deeper than they, while the base of the bladder is still more deeply placed than the prostate; and hence it is that the end of the rectum is allowed to advance so near the pendent bulb that those parts are in a great measure concealed by these. As the apex of the prostate is an inch (more or less) deeper than the bulb, so the direction of that portion of the urethra which intervenes between the two is according to the axis of the pelvic outlet—the prostatic end of the canal being deeper than the part near the bulb. This fact has its practical significance in lithotomy and catheterism. Viewing the course of the pudic arteries in reference to the median line, we see that they are removed from it at a wider interval behind than before; and that where they first enter the perinæal space winding around the spines of the ischia, they are much deeper (on the same plane as that of the base of the bladder) than they are where they approach the bulb of the urethra. Throughout their perinæal course the pudic arteries are separated from the bladder and the rectum by the levator ani muscle and by the deep perinæal fascia, between the two layers of which they are enclosed. While the median line naturally marks the perinæal space into lateral halves, in both of which are to be found identical parts, it is only by an imaginary line drawn transversely from one tuber ischii to the other that the pelvic outlet can be divided into an anterior and posterior space. The line B, drawn from the posterior border of one tuber to that of the other, cuts the median line at right angles where it crosses the middle of the anus. In the anterior of those spaces appear all the parts now noticed; into it the bladder and bowel open, as being the pelvic outlet, and to its axis all the lines of abdominal force tend to render those organs operative.

Fig. 2.—While the median line, A, divides the pelvic outlet into lateral spaces, and the transverse line, B, divide sit into an anterior and a posterior space, we have isolated a triangular interval on either side, of which the median line is the inner side, the transverse line the base, and the ischio-pubic ramus, F J, the outer side. At this interval (the left) the side of the prostate and of the neck of the bladder being most superficial, and usually less complicated with other important structures, are therefore most accessible to the lithotomist. Considering the relations of the parts in reference to this space, the lithotomist will see that a considerable portion at its inner inferior or anal angle is occupied by the lateral half of the end of the rectum overlapping the prostate in front, while along its outer side the pudio artery courses forwards. The position of the bowel and of the vessel therefore determines the line of incision necessary to open the bladder through the lateral lobe of the prostate, which projects also into this space. The line of section, C, commencing over the bulb about an inch in front of the anus, would, if carried downwards and outwards to a point midway between the anus and the tuber ischii, avoid the rectum on its inner side and the pudic artery externally; whereas, if the parts were divided in the direction of the line D, that is, midway through the space, and parallel with the ischio-pudic ramus, not only the rectum, but the prostate too, would be missed, and the pudic artery or its principal branches endangered, more especially if the artery of the bulb had a low origin.

Fig. 3.—The bladder, L L, is a perfectly symmetrical organ, and as such is situated central in the pelvis. Its base, viewed through the pelvic outlet, shows its appendages on one side to be the exact counterparts in form, size, and situation, of those on the other. The median line, A, exhibits its bilateral symmetry, the transverse line, B, shows its antero-posterior dissimilarity. The urethra, G, is median. The prostate, K K, is bilobed; its sides being united at the median line. The vasa deferentia, N N, enter the base of the prostate close on either side of the median line; and immediately on the outer side of those ducts are the vesiculæ seminales, M M, each one entering the base of the prostatic lobe of its own side. External to the vesiculæ are the ends of the ureters, J J, entering the sides of the base of the bladder at about half an inch behind, and to the outer side of, the prostatic lobes. The relations of those parts are invariable, but the disposition of the arteries is not always so. In Fig. 1 the pudic artery has its usual course deeply along the inner side of the ischio-pubic ramus, is superficial to the levator ani muscle, and gives off its branches in the normal order, thus escaping the proper lines, C D, of incision in lithotomy. In Fig. 2 the pudic artery holding the same relative position gives off the artery of the bulb opposite the anus, and this considerable branch, in approaching the bulb, crosses the lines of incision. In Fig. 3 the pudic artery courses in the pelvis under cover of the levator ani, and in contact with the base of the bladder and the left lobe of the prostate, where it must inevitably be severed in the line of section, K D, by whomsoever made.

Fig. 4.—The muscular structures in connexion with that part of the urethra which intervenes between the bulb and the prostate do not appear in all subjects alike, either as to number or form. In some they are altogether wanting; in others a few of them only appear; in others they seem to be not naturally separable from the larger muscles which are always present. Hence it is that the opinions of anatomists are so conflicting regarding them. In Fig. 4 I have summed together all the facts recorded concerning them, and judging from what I have myself observed, those muscles appear to me to be of the same category, and which, if they were all present, would assume the serial order of P* P O N M. All of them arise from the ischio-pubic ramus, and are inserted in the median line. The part P P, passing under, G, the urethra, is that described by Santorini as "levator urethræ." The part P* passing above the urethra is that described by Mr. Guthrie. The part M is the well-known "transversalis perinæi," between which and the part P, there occasionally appears the part N, which is the "transversalis alter" of Albinus, and the part O, which represents the "ischio-bulbosus" of Cruveilhier. When one or more of those muscles are omitted from the series there occurs anatomical variety, and hence contrariety of opinion, fruitless though endless. Of forms considered comparatively, we construct a uniform series, which is at once intelligible, but while forms are separately and irrelatively contemplated, they appear as meaningless hieroglyphics as the algebraic symbols $a + c - d = 11$ are if the mind be devoid of calculation.

Fig. 5.—The prostate and adjoining part of the urethra, G, are in some instances closely embraced by two symmetrical fasciculi of muscular fibres, H H, which are situated behind those, P P, in Fig. 4. They arise from the posterior lower border of the symphysis pubis, and, descending on either side of the prostate, join beneath it. This is the muscle which Santorini described as the "levator prostatæ," which Winslow named "le prostatique supérieur," which Wilson named "pubo-urethralis," which Müller mentions as "not existing," which Mr. Guthrie describes as forming (when existing) with the muscular parts P* PP, Fig. 4, his "compressor isthmi urethræ," and which M. Cruveilhier recognises as *"part of the levator ani muscle,"* which doubtless is the true interpretation of it, and for these reasons: 1st, it arises from the symphysis pubis, and is inserted with the levator ani, L L, into the perinæal median line; 2nd, the fibres of both muscles overlie the forepart of the prostate, present the same serial parallel order, and are behind the deep perinæal fascia; 3rd, the one is not naturally separable from the other, but in all cases each appears as the part of a whole quantity, which, like the diaphragm, is incapable of partial action, and, as antagonistic of that muscle, is the elevator, not only of the anus, but of the prostate, bladder, and the whole perinæum at the same time.

Fig. 6 represents the natural relative position and forms of the bladder and urethra with the rectum. The two former parts have been centrally cleft through the pubic symphysis, B, which coincides with their middles, and with the common median line. The general direction of the urethra measured, in its relaxed state, from the vesical orifice, F, to the glans penis, is usually described as having the form of the letter S laid procumbent thus ∿; but as the anterior half of the canal is free and moveable in all directions, and permits of varying the general form while the posterior half is fixed, the latter should have chief attention, since upon its peculiar form and relative position depends most of the difficulty in catheterism. That portion of the urethra which intervenes between the neck of the bladder, HF, and the point, N, where the penis is suspended from the front of the symphysis pubis by the suspensory ligament assumes very nearly the form of a semicircle, whose anterior curve looks towards the forepart, and whose posterior curve is turned to the back of the pubes. The pubic arch spans crossways the middle of this part of the urethra—the symphysis pubis, B, being directly over the bulb, M. The two extremes of the posterior curve of the urethra, N F, and the lower border of the symphysis pubis occupy in the adult the same antero-posterior level, and it follows, therefore, that the distance to which the urethra at its bulb is removed from the pubic symphysis above must equal the depth of its own curve, which measures about an inch vertically; and here the canal passes through the circular opening in the triangular ligament, the anterior layer of which structure sheaths the canal in its passage forwards, while the posterior layer sheaths it backwards into the pelvis, and forms a capsule for the prostate, H H. That portion of the canal which lies behind the ligament, and ascends obliquely backwards and upwards to the vesical orifice, on a level with the symphysis pubis in the adult, should be remembered as varying both in direction and length in individuals of the extremes of age. In the young this variation is owing to the usual high position of the bladder, projecting as it does from out of the pelvis into the hypogastric region, whilst in the old it may be caused by an enlarged state of the prostate. The curve of the posterior half of the urethra now described is permanent in all positions of the body, while the anterior half being free, relaxed, and moveable may, by traction towards the umbilicus, be made to continue in the direction of the former, and this is the general form it assumes when a bent catheter of ordinary shape is passed along it into the bladder. The length of the entire male urethra varies at different ages, and in different individuals of the same age, and its structure in the relaxed state is so very dilatable, that it is not possible to estimate the calibre of its canal with fixed accuracy. As a general rule, the urethra is much more dilatable in the aged than in the adult. The three portions into which the urethra is described as being divisible are the spongy, the membranous, and the prostatic. These names indicate the difference in the structure of each part. The spongy portion is the longest of the three, and, extending from the glans to the bulb, may be said on a rough, but for practical purposes a sufficiently accurate estimate, to comprise seven parts of the whole urethra, which measures nine. The membranous and prostatic portions measure respectively one part of the whole. These relative proportions of the three parts are maintained in different individuals of the same age, and in the same individual at different ages. The spongy part, commencing at the glans, occupies the inferior groove formed between the two united corpora cavernosa of the penis, and is subcutaneous as far back as the scrotum under the pubis, between which point and the bulb it becomes embraced by the accelerator urinæ muscle. The bulb and glans are enlargements of the spongy texture, and do not affect the calibre of the canal next them. While the spongy texture is injected with blood, the canal of it is rendered narrower than otherwise. The canal of the urethra is uniform, cylindrical between the meatus and the apex of the prostate. The meatus is the narrowest part of it, and the prostatic part is the widest. At the point of junction between the membranous and spongy portions behind the bulb the canal is described as being naturally somewhat constricted. Behind the meatus exists a dilatation of the canal named fossa navicularis; and at the bulb is another named sinus of the bulb. Muscular fibres are said to enter into the structure of the urethra, but I could never discern them. The urethra is lined by a delicate mucous membrane presenting longitudinal folds which become obliterated by distension, and its entire surface is numerously studded with the orifices of mucous cells (lacunæ), one of which, larger than the rest, appears on the upper side of the canal, near the meatus. Some of these lacunæ are nearly an inch long, and all of them open in an oblique direction forwards. Instruments, having pointed apices, are liable to enter these ducts, and to make false passages. The ducts of Cowper's glands, which are situated behind the bulb, between the layers of the triangular ligament open by very minute orifices in the canal on the sides of the spongy urethra anterior to and near

fibrous membrane (obturator fascia, seemingly a production of the sacro-sciatic ligament), course thence obliquely forwards and downwards, between the obturator internus muscle and the origin of the levator ani to the forepart of the perinæum, appearing here opposite the bulb of the urethra. The principal branches given off from the pudic artery of either side, are (1st) the inferior hæmorrhoidal, to supply the sphincter ani muscles; (2nd) the transverse and superficial perinæal, to the muscles of the urethra; (3rd) the artery of the bulb of the urethra; (4th) the artery of the corpus cavernosum of the penis; and (5th) the dorsal artery of the penis. The pudic nerve gives off branches corresponding in number and place with all those of the artery (except the third and fourth), and having the same destination. The arteries of the pelvic viscera are severally accompanied by one or more veins. Around the prostate is frequently observable a plexus of veins; and those which ascend the rectum from the anus are generally large and numerous, and devoid of valves. When those veins become varicose, owing to an obstruction of their circulation, however caused, the rectum is liable to be affected with hæmorrhoids, or to assume a hæmorrhagic tendency, vicarious with menstruation.

When the bladder and rectum are examined with a view to determine whether the active functions attributed to them depend upon force inherent to their structures, the appearances they present do not seem to me to indicate the reasonableness of that conclusion. The bladder, in its normal state, appears as a mere membranous receptacle, in the walls of which muscular fibres are scarcely distinguishable, and those which are at all evident are of the involuntary class, as shown by their microscopic character, and are supplied by nerves of the sympathetic system. From this it must be evident that the bladder is an organ wholly out of the control of the will, and that a degree of mere tonicity is all that it can derive from its muscular tunic. The rectum is more distinctly muscular than the bladder. The rectum has an outer layer of longitudinal, and an inner layer of circular, fibres; but these are of the same class (involuntary) as those forming the muscular coat of the other parts of the alimentary canal, and their nerves are derived from the sympathetic system likewise. That the rectum, therefore (devoid of the anal sphincters), is not a voluntary organ, and that any action which it can perform is but such as that of which the other parts of the intestinal canal are capable—viz., a vermicular motion—must be also very evident. Under these circumstances, and considering that the action necessary to void their contents is both voluntary and powerful, it must be inferred that other agents than themselves produce that effect. From the position of the pelvic organs relative to those of the abdomen, it appears to me that this inference is justifiable.

As the abdomen and pelvis form one general cavity, the organs contained in both regions are thereby intimately related; and so the actions exerted by the abdominal parietes on their contained viscera must cause these to transmit all impressions made on them to the pelvic organs. By the contraction of the diaphragm and the abdominal muscles, the whole abdominal viscera are subjected to compression; and, descending by that influence and by their own gravity, they compress the pelvic organs, and at the same time the muscles guarding the pelvic outlet, and the orifices of the bladder and rectum becoming relaxed or contracted according to the requirements, allow the perinæum to be protruded or sustained voluntarily. Thus it is, that force originating in the muscular parietes of the thorax and abdomen is brought so to bear upon the pelvic organs, as to become the principal means whereby the contents of these are evacuated. The abdominal muscles are, during this act, the antagonists of the diaphragm; while the perinæal muscles in action antagonize both, but in their state of relaxation permit the former to exert their full expulsive action in reference to the pelvic viscera, of which latter being little more than passive recipients of their contents, it may hence be said that the voluntary processes of defæcation and micturition are performed rather *for* them than *by* them. The relations which they bear to the abdomen and its viscera, and their dependence upon those relations for the due performance of those processes, are sufficiently explained by anatomical, physiological, and pathological facts. The muscles of the thorax, abdomen, and perinæum are all served by nerves of the cerebro-spinal axis; and they form a system whose actions in government of the viscera of the trunk are consentaneous, whether voluntary or reflex. They are capable of a united action, or, like flexors and extensors, the action of some of them is obeyed by the relaxation of others, according to the viscus to be operated on. When the spinal cord suffers injury in the cervical spine above the origin of the phrenic nerve, immediate death supervenes, owing to a paralysis of the respiratory system of muscles. If the cord be injured in the lower dorsal spine, the diaphragm supplied by the phrenic nerve above is capable of action, and so likewise are the intercostal muscles which are served by the intercostal nerves, but the abdominal and perinæal muscles are paralyzed, and all control over the pelvic organs is lost. When the cord is injured in the lower-lumbar spine, the abdominal muscles supplied by the lumbar nerves are active, together with the diaphragm, but the perinæal muscles supplied by the sacral nerves are paralyzed, and the pelvic organs are not within the sphere of volition. From these and the other facts mentioned, we may, I think, safely entertain the following opinion: that the term "paralysis" of the bladder or rectum, when that event attends spinal injuries, means, or should mean, only a paralytic state of the abdomino-pelvic muscular apparatus, entirely or in part; for in fact neither of those organs ever acts voluntarily *per se* any more than the stomach does: that therefore the name "detrusor urinæ," as applied to the muscular coat of the bladder, is as much a misnomer (if it be meant that the act of voiding the bladder at will be dependent upon that coat) as would be the name "detrusor" applied to the muscular coat of the stomach, under the meaning that this is the agent in the convulsive effort of vomiting: that, on the contrary, the relative position of the pelvic organs, and the evident manifestation of abdominal agency in the expulsory effort in respect to those organs, clearly indicate that the abdominal parietes, compressing the viscera against the pelvic organs, are the true detrusors; and that the only action of the perinæal muscles is one of retention by sphinction, whereas their relaxation is required to allow of the abdominal effort to take effect: that the lines of force originating in the diaphragm are, by the concave form of that muscle, directed to the other abdominal parietes laterally and in front, and are by these deflected downwards and backwards through all points of the plane of the pelvic brim, and consequently impinge upon all the opposing surfaces of the pelvic organs. The relative position of those organs is such as to receive those lines of force in full operative compression: the bladder receives them direct on its convex summit: the rectum receives them direct on its front, by reason of its anterior curve, which is resistingly supported by the sacrum behind and by the coccyx below, and thence they are deflected through the base of the pubic arch in front, and according to the direction of the axis of the pelvic outlet.

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the bulb. The urethra within the prostate consists simply of the mucous membrane lining the canal of that body. On the floor of the prostatic urethra appears the crest of the veru montanum, P, upon which the two seminal ducts open by distinct orifices directed forwards. On either side of the veru montanum the floor of the prostate is perforated by what are regarded as the "excretory ducts" of this so-called *gland*. Projecting from the lower part of the neck of the bladder appears a small nipple-shaped body, F, named by Lieutaud the uvula vesicæ; it is the same as that which (when enlarged) is named by Home the "third lobe of the prostate," but the part does not appear as proper to the bladder in its normal condition. A little backwards, and external to the uvula, are the orifices, G G, of the ureters, opening on two ridges of fibrous substance, directed from the sides of the base of the bladder forwards and inwards to the uvula, which is central. These are the fibres which have been named by Sir C. Bell as the "muscles of the ureters;" but as they do not exist in the normal condition of the bladder, the function assigned to them by that anatomist may be questioned; and the same may be said of the fibres which, surrounding the vesical orifice, are believed by some to act as a "sphincter vesicæ." In those cases in which the muscles of the ureters exist as distinct ridges between the uvula and the openings of the ureters, they form the sides of a triangular space named "trigone vesical," of which a transverse line drawn between their posterior ends represents the base, and the uvula the apex. Behind the trigone there is a depression in the base of the bladder named "bas fond," which, when a stone is formed in that organ, usually receives that body.

Fig. 2.

Fig. 3.

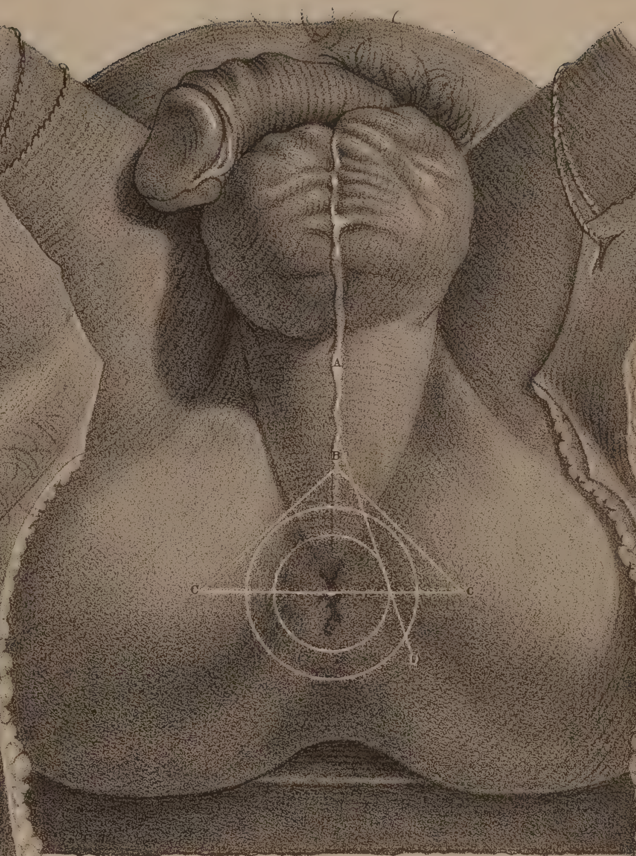


Fig. 1.

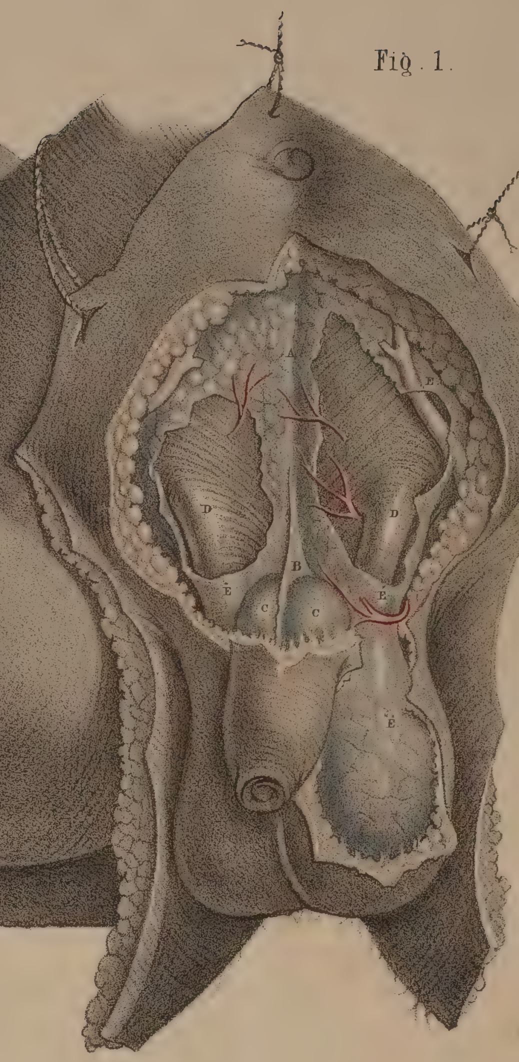


Fig. 4.

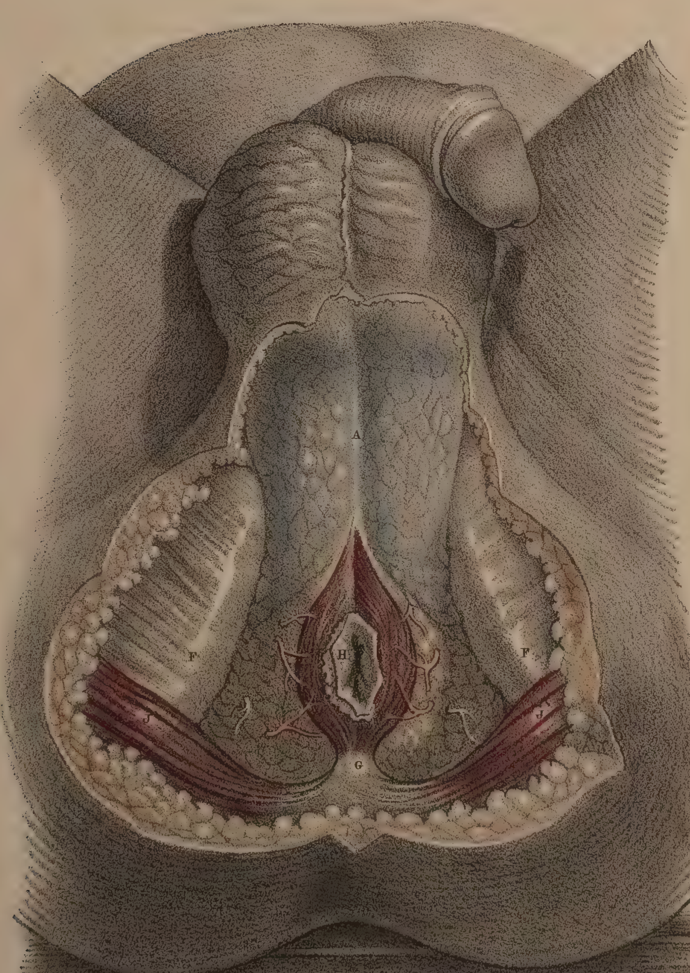
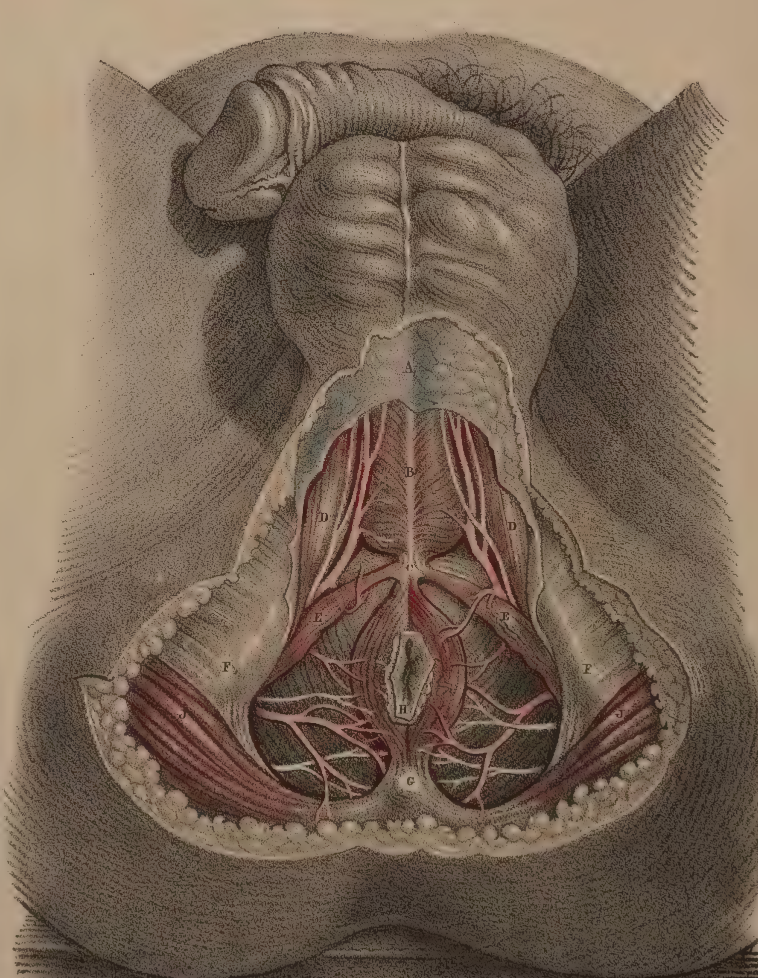


Fig. 5.



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COMMENTARY ON PLATES XLII. & XLIII.

THE SURGICAL DISSECTION OF THE SUPERFICIAL AND DEEP STRUCTURES OF THE MALE PERINÆUM, LITHOTOMY, &c.

The median line of the body is marked as the situation where the opposite halves unite and constitute a perfect symmetrical figure. Every structure—superficial as well as deep—which occupies the median line is either single, by the union of halves, or dual, by the cleavage and partition of halves. The two sides of the body being absolutely similar, the median line at which they unite is therefore common to both. As union along the median line is an *occlusion* taking place by the junction of sides; so every hiatus or opening, whether normal or abnormal, which happens at this line, signifies an *omission* in the process of central union. Occurring at the same time with this process of central union, is manifested another process—that of the increase or development of median parts from *minus* to *plus;* and of all such forms, whether normal or abnormal, the lesser is to the greater but as an *arrest* in development simply. The sexual peculiarities are the results of the operation of both those laws; and all forms which are anomalous to either sex may be interpreted as gradations in both modes of development—thus: taking the developmental line as represented by the serial numerals 9, 8, 7, 6, 5, 4, 3, 2, 1, of the extremes of which lines, 9, as the quantitively greatest may be regarded as the male conformation, and 1 as the quantitively least that of the female, so all the intermediate quantities being as *plus* to 1, and as *minus* to 9, manifest themselves as the anomalies—as the so-called *lusus naturæ;* a few of these latter occasionally come under the notice of the surgeon.

The region which extends from the umbilicus to the point of the coccyx is marked upon the cutaneous surface by a central line dividing the hypogastrium and the penis, and by a raphè dividing the scrotum and the perinæum respectively into equal and similar sides. The *umbilicus* is a *cicatrix* formed after the metamorphosis of a median fœtal structure—the *placental cord,* &c. In the normal form, the *meatus urinarius* and the *anus* coincide with the line of the median raphè, and signify omissions at stated intervals along the line of central union. Between those openings the *labia pudendi* are as a *bicleft scrotum.* When between these intervals the process of union happens likewise to be arrested, malformations are the result; and of these the following are examples:—*Extrusion of the bladder* at the hypogastrium is caused by a *congenital hiatus* at the pubic part of the *linea alba,* which is in the median line; *Epispadias,* which is an urethral opening on the dorsum of the penis; and *Hypospadias,* which is a similar opening on its under surface, are of the same nature—namely, *omissions in median union* at unusual places. *Hermaphrodism* may be interpreted simply as a structural *defect,* compared to the normal form of the *male,* and as a structural *excess* compared to that of the *female. Spina bifida* is a congenital malformation caused by a *hiatus* in union along the posterior median line of the sacrum or the lumbar spine, and admitting a protrusion of the spinal membranes. As the process of union along the median line may err by a defect or omission, so may it, on the other hand, err by an excess in fulfilment, as, for example, when the urethra, the vagina, or the anus are found to be imperforate. As the median line of union thus seems to influence the form of the hypogastrium, the genitals, and the perinæum, the dissection of these parts has been here conducted accordingly.

On tracing the common integument from the pubic region through the scrotum to the perinæum, we find it so disposed in folds as to indicate the forms of the principal subjacent parts and those of the membranes especially. At either side it marks the femoro-pubic folds by being intimately attached to Poupart's ligament, and in those folds the spermatic cords may be felt. Drooping thence loosely it forms the scrotal bag inclosing the pendent testicles, and the middle of its forepart is marked by a raphè, which extends through the perinæum to the anus. In this situation it appears marking a space of triangular form inverted, the base of which is at the line of union between the scrotal and perinæal skin, the apex of which is at the anus, and the sides of which are continuous with the femoro-pubic folds. Throughout this extent the skin may be regarded as surgically distinct from that of the thighs and anal region, and on removing it we shall find the superficial fascia to be similarly disposed and for a similar purpose—that of isolating the inguino-perinæal region from neighbouring parts.

By dissecting the skin and subjacent adipose membrane from the hypogastrium, we expose the superficial fascia. This membrane, E E E*, Fig. 1, is, in the middle line, adherent to A, the linea alba, and thereby contributes to form the central depression which extends from the navel to the pubes. The adipose tissue, which in some subjects greatly accumulates on either side of the linea alba, renders this depression more marked in them. At the folds of the groin the fascia is found adherent to Poupart's ligament, and this also accounts for the depressions in both these localities. From the central linea alba to which the fascia adheres, outwards on either side to the folds of both groins, the membrane forms two distinct sacs, which droop down in front, so as to invest the spermatic cords, D D, the testicles, E**, and the penis, C C, in a manner similar to that of the skin covering these parts. As the two sacs of the superficial fascia join each other at the pubic symphysis coinciding with the linea alba, they form by that union the suspensory ligament of the penis, B, which is a structure precisely median.

The superficial fascia having invested the testicles each in a distinct sac, the adjacent sides of both these sacs, by joining together, contribute to form the median septum scroti, D D, Fig. 2. In the perinæum, Fig. 4, the fascia, A, may be traced from the back of the scrotum to the anus. In this region the membrane is found to adhere laterally to the rami of the ischium and pubes; whilst along the median perinæal line the two sacs of which the membrane is composed unite, as in the scrotum, and form an imperfect septum. In front of the anus, beneath the sphincter ani, the fascia degenerates into cellular membrane, one layer of which is spread over the adipose tissue in the ischio-rectal space, whilst its deeper and stronger layer unites with the deep perinæal fascia, and by this connexion separates the urethral from the anal spaces. The superficial fascia of the hypogastrium, the scrotum, and the perinæum forming a continuous membrane, and being adherent to the several parts above-noticed, may be regarded as a general double sac, which isolates the inguino-perinæal region from the femoral and anal regions, and hence it happens that when the urethra becomes ruptured, the urine which is extravasated in the perinæum is allowed to pass up over the scrotum and the abdomen, involving these parts in consequent inflammation, whilst the thighs and anal space are exempt from that occurrence. The tunicæ vaginales, which form the immediate coverings of the testicles, C C*, Fig. 2, cannot be entered by the urine, as they are distinct sacs originally

FIGURES OF PLATE XLII.

Fig. 1.—A, Linea alba.—B, Suspensory ligament of the penis.—C C, Corpora cavernosa penis.—D D, Spermatic cords.—E E* E**, Superficial fascia of the hypogastrium forming sheaths for the cords and testicles in the scrotum.

Fig. 2.—Septum pectiniforme between the cut corpora cavernosa.—B, Urethra in section.—C C*, Right and left testicles in the tunicæ vaginales.—D D, Scrotal septum.

Fig. 3.—A, Perinæal raphè.—B, Situation of bulb of urethra.—C C, Situation of the tubera ischiorum.—B C C, Lithotomic angle.—B D, Lithotomic line of incision cutting a segment from the greater circle, representing the dilated rectum, and touching the lesser circle representing the collapsed rectum.

Fig. 4.—A, Median line of the superficial perinæal fascia.—FF, Tubera ischiorum.—G, Point of the coccyx.—H, Anus.—J J, Perinæal margin of the glutæi muscles.

Fig. 5.—Other parts lettered as in Fig. 4.—B, Accelerator urinæ.—C, Tendinous perinæal centre.—D, Erectores muscles on the crura penis.—E E, Transversæ perinæi muscles.

protruded from the abdomen. It is in consequence of the imperfect state of the inguino-perinæal septum of the fascia, that urine effused into one of the sacs is allowed to enter the other.

Like all the other structures which join on either side of the median line, the penis, A B, Fig. 2, appears as a symmetrical organ. While viewed in section, its two corpora cavernosa are seen to unite anteriorly beneath the symphysis pubis, and by this union to form a septum "pectiniforme;" posteriorly they remain distinct and lateral, D D, Fig. 5, lying along the ascending pubic rami to which they and the erectores penis muscles in front of them are attached. Where the corpora cavernosa are separate and in front of the ischio-pubic rami they are named the crura penis. The urethra, B, Fig. 2, is also composed of two sides, united along the median line, but forming between them a canal by the cleavage and partition of the urethral septum, and just as if the septum pectiniforme remained of distinct sides, each layer being bent outwards from the median line and forming a canal between them. That this is the signification of the form of the urethral canal there are many evidences to show: that the urethra is no exception to the general rule of all median parts, being duplex and hence symmetrical, is rendered apparent in an appendage of the urethra itself, viz., the bulb, which is frequently bilobed. All the other structures of the perinæum will be seen to be either double and lateral, or single and median, according as they stand apart from, or approach, or occupy the central line.

The perinæum, Figs. 4, 5, is that space which is bounded above by the arch of the pubes; behind by the os coccygis; and the lower borders of, J J, the glutæi muscles and sacro-sciatic ligaments; and laterally by F F, the ischio-pubic rami. The osseous boundaries can be felt through the integuments. Between the back of the scrotum and the anus the perinæum swells on both sides of the raphè, A B, Fig. 3, and assumes a form corresponding with the bag of the superficial fascia which encloses the structures connected with the urethra. The anus is centrally situated in the depression formed between the ischiatic tuberosities and the double folds of the nates.

The perinæum, Fig. 5, is, for surgical purposes, described as divisible into two spaces (anterior and posterior) by a transverse line drawn from one tuber ischii, F, to the other, and crossing in front of the anus. The anterior space, ADDC, contains the urethra; the posterior space, CFFG, contains the rectum. The central raphè, ABCHG, traverses both these spaces. The anterior or urethral space is (while viewed in reference to its osseous boundaries) triangular in shape, the apex being formed by the pubic symphysis beneath A, Fig. 3, whilst two lines drawn from A to C C, would coincide with the ischio-pubic rami which form its sides. The raphè in the anterior space indicates the central position of the urethra, as may be ascertained by passing a sound into the bladder, when the shaft of the instrument will be felt prominently between the points AB. Behind the point B, the sound or staff sinks deeper in the perinæum as it follows the curve of the urethra backwards to the bladder, and becomes overlaid by the bulb, &c. The ischiatic tuberosities are, in all subjects, sufficiently prominent to be felt through the integuments, &c.; and the line which, when drawn from the one to the other, serves to divide the two perinæal spaces, forms the base of the anterior one. In well-formed subjects, the anterior space is equiangular, the base being equal to each side; but according as the tuberosities approach the median line, the base becomes narrowed, and the triangle is thereby rendered acute. These circumstances influence the direction in which the first incision in the lateral operation of lithotomy should be made. When the tuberosity of the left ischium stands well apart from the perinæal centre, the line of incision, BD, Fig. 3, is carried obliquely from above downwards and outwards; but in cases where the tuberosity approaches the centre, the incision must necessarily be made more vertical; whereby the rectum, represented by the outer larger circle in its distended state and by the inner smaller circle in its undistended state, becomes more or less liable to be wounded. The posterior perinæal space may be described on the surface by two lines drawn from C C, the ischiatic tuberosities, to the point of the coccyx, and forming its sides and apex, whilst the transverse line is its base.

By removing the integument and superficial fascia, Fig. 5, we expose the superficial vessels and nerves, together with the muscles in connexion with the urethra and the anus. In front of the anus appears a tendinous central point, C, affording a common attachment to the following muscles: from it arises the accelerator urinæ, the fibres of which, symmetrically arranged, embrace the urethra and its bulb. Into it is inserted the sphincter ani, which, arising from the point of the coccyx symmetrically, surrounds the anus. Those two muscles occupy the median line, which is tendinous, to which their fibres are attached, and by which each is marked into distinct lateral muscles united. Into the same central tendinous point are also inserted two small muscles (transversæ perinæi), each of which arises from the tuber ischii of its own side, and will be observed naturally to serve to mark the perinæum into the anterior or urethral, and the posterior or rectal spaces. Considering the disposition of all those muscles, it will be evident that, in order that each may be specially effective, their actions must be united and antagonistic by traction from a common centre. On the crura penis, and arising from the inner sides of the ischiatic tuberosities, appear the erectores penis muscles, between each of which and the accelerator urinæ, the superficiales perinæi arteries and nerves course forwards to the scrotum, after giving off their first most considerable branches in the direction of the transversales muscles. Behind those muscles, in the ischio-rectal fossa, appear the numerous inferior hæmorrhoidal small arteries and nerves. All those, arterial and nervous, are derived from the pudic artery and nerve.

The perinæal muscles having been brought fully into view, Plate XLIII., Fig. 1, we notice that on either side of the anterior space appears a small angular interval, formed between the accelerator urinæ, the erector penis, and the transverse muscle. Along the surface of this interval we found the superficial perinæal artery and nerve passing forwards; and deep in it, beneath these, may now be observed, E, the artery of the bulb, arising from the pudic, and crossing inwards, under cover of the anterior layer of the membrane, C, named the deep perinæal fascia. The first incision in the lateral operation of lithotomy is commenced over the inferior inner angle of this interval.

The muscles occupying the anterior perinæal space require to be removed, Fig. 2, in order to expose the urethra, A B, the crus penis, D, and the deep perinæal fascia. This being done, the fascia will be now seen stretched across the subpubic triangular space, reaching from one ischio-pubic ramus to the other, whilst by its lower border, C C, corresponding with the line of the transversæ perinæi muscles, it becomes continuous with the superficial fascia, in the manner before described. The deep perinæal fascia (triangular ligament) encloses between its two layers, on either side of the urethra, the pudic artery, E, the artery of the bulb, Cowper's glands, C*, and some transverse muscular fibres occasionally to be met with, to which the name "Compressor urethræ" has been assigned. At this stage of the dissection, as the principal vessels and parts composed of erectile tissue are now in view, their relative situations should be well noticed, so as to avoid wounding them in the several cutting operations required to be performed in their vicinity.

Along the median line (marked by the raphè) from the scrotum to the coccyx, and close to this line on either side, the vessels, with the exception of the artery of the bulb, are unimportant as to size. The urethra lies along the middle line in the anterior perinæal space; the rectum occupies the middle in the posterior space. When either of these parts specially require to be incised—the urethra for impassable stricture, &c., and the lower part of the rectum for fistula in ano—the operation may be performed without fear of inducing dangerous arterial hæmorrhage. With the object of preserving from injury these important parts, deep incisions at, or approaching to, the middle line must be avoided. The outer (ischio-pubic) boundary of the perinæum is the line along which the pudic artery passes. The anterior half of this boundary supports also the crus penis; hence, therefore, in order to avoid these, all deep incisions should be made parallel to, but removed to a proper distance internal from this situation. The structures placed at the middle line, and those in connexion with the left perinæal boundary, require (in order to insure the safety of these parts) that the line of incision necessary to gain access to the neck of the bladder in lithotomy should be made through the left (as being the more convenient) side of the perinæum from a point midway between B, the bulb, and D, the crus penis above, to a point, K, midway between the anus, F, and the tuber ischii, H, below. As the upper end of this incision is commenced over the situation of the superficial perinæal artery and the artery of the bulb, the knife at this place should only divide the skin and superficial fascia. The lower end, K, just clears the outer side of the dilated lower part of the rectum. The middle of the incision is over the left lobe of the prostate gland and neck of the bladder, which parts, together with the membranous portion of the urethra, are still concealed by the deep perinæal fascia, the structures between its layers, and the anterior fibres of K K, the levator ani muscle. The incision, if made in due reference to the relative situation of the vascular parts above noticed, will leave them untouched; but when the pudic artery, or some one of its branches, deviates from its ordinary course, and crosses the line of incision, a serious hæmorrhage will ensue, despite the anatomical knowledge of the most experienced operator. When it is requisite to divide the super-

Fig. 1.

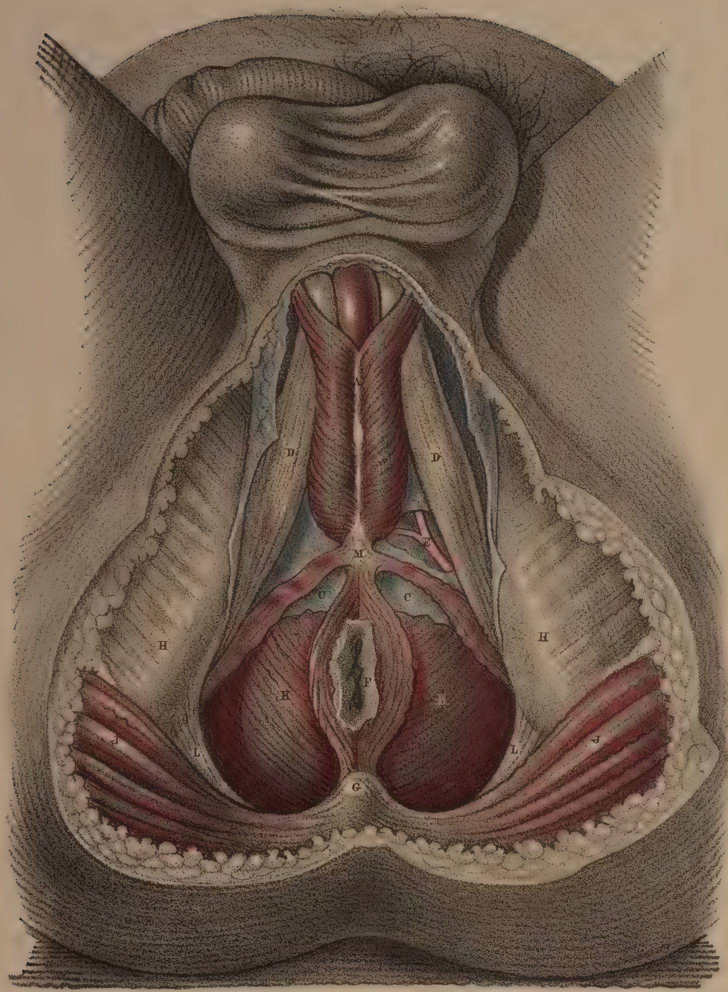


Fig. 2.

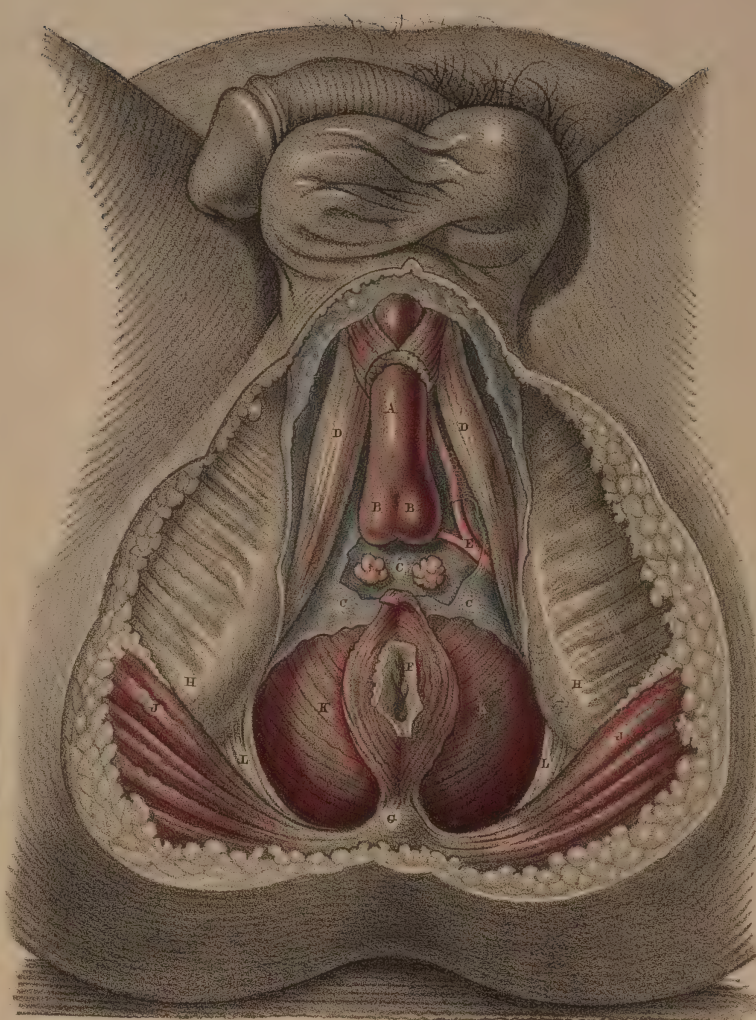


Fig. 3.

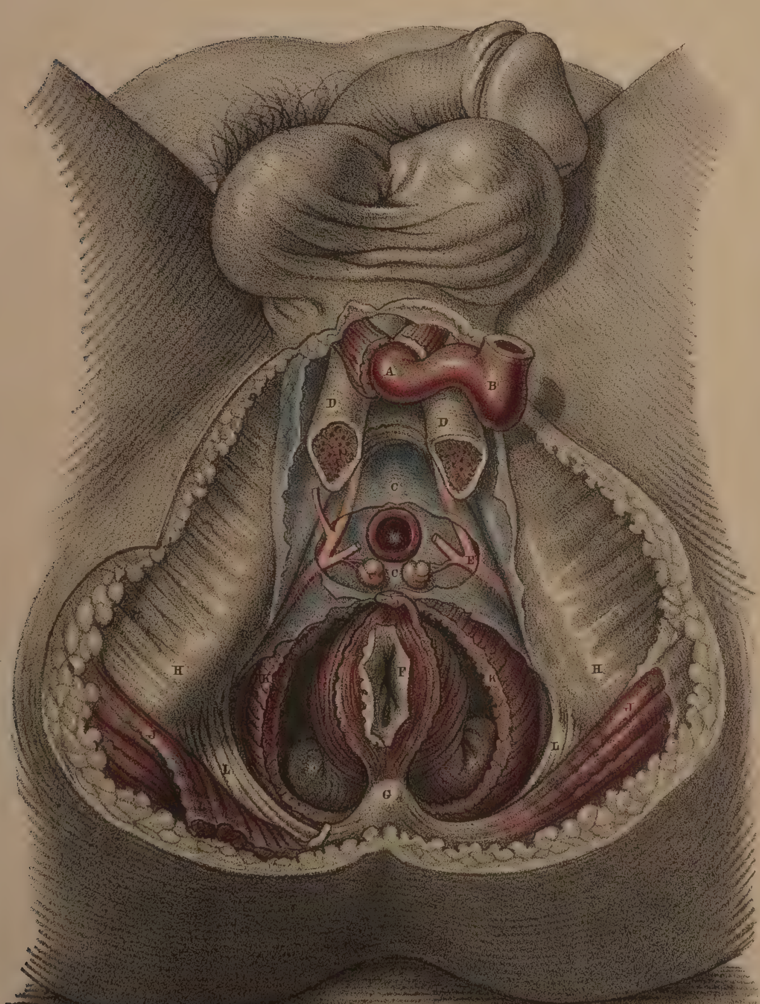
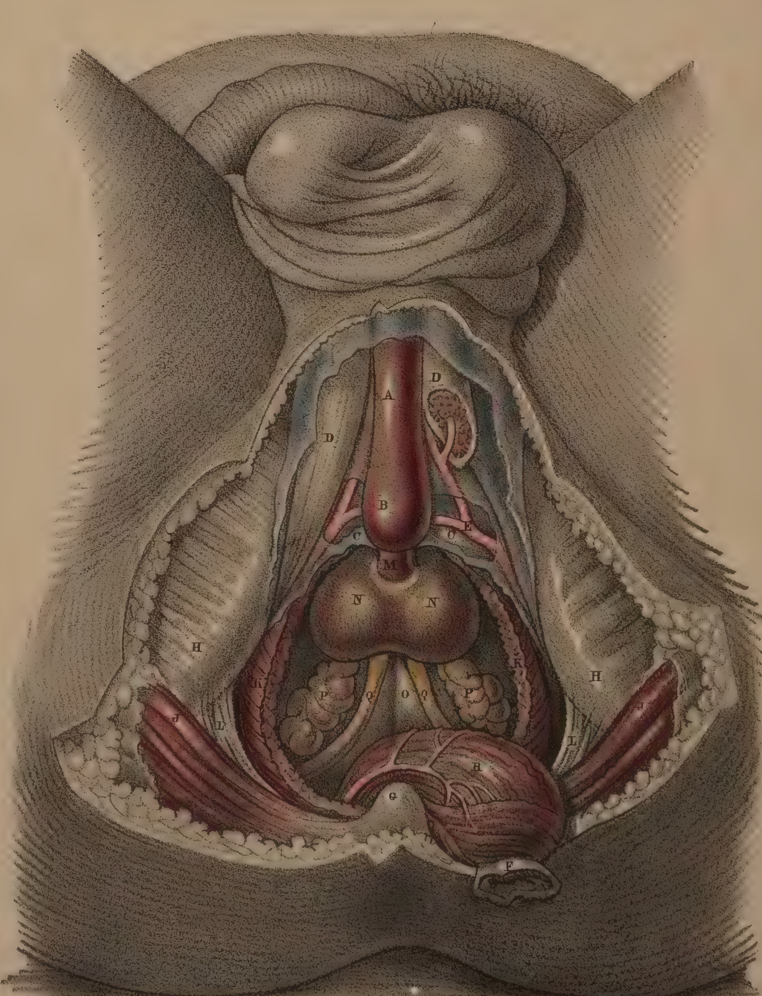


Fig. 4.



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ficial and deep sphincter ani, as in the operation for complete fistula in ano, if the incision be made transversely in the ischio-rectal fossa, the hæmorrhoidal arteries and nerves converging towards the anus will be the more likely to escape being wounded.

The urethra, at its membranous part, M, Fig. 3, Plate XLIII., which commences behind the bulb, perforates the centre of the deep perinæal fascia, C C, at about an inch and a half in front of F, the anus. The anterior layer of the fascia is continued forwards over the bulb, whilst the posterior layer is reflected backwards over the prostate gland. Behind the deep perinæal fascia, the anterior fibres of K, the levator ani muscle, arise from either side of the pubic symphysis posteriorly, and descend obliquely downwards and forwards, to be inserted into the sides of R R, the rectum, above the anus. These fibres of the muscle, and the lower border of the fascia which covers them, lie immediately in front of the prostate, N N, Fig. 4, and must necessarily be divided in the operation of lithotomy. Previously to disturbing the lower end of the rectum from its natural position in the perinæum, its close relation to the prostate and base of the bladder should be noticed. While the anus remains connected with the deep perinæal fascia in front, the fibres of the levator ani muscle of the left side may be divided; and by now inserting the finger between them and the rectum, the left lobe of the prostate can be felt in apposition with the forepart of the bowel, an inch or two above the anus. It is owing to this connexion between these parts that the lithotomist has to depress the bowel, lest it be wounded while the prostate is being incised. If either the bowel or the bladder, or both together, be over-distended, they are brought into closer apposition, and the rectum is consequently more exposed to danger during the latter stages of the operation. The prostate being in contact with the rectum, the surgeon is enabled to examine by the touch, *per anum*, the state of the gland. If the prostate be diseased and irregularly enlarged, the urethra, which passes through it, becomes, in general, so distorted, that the surgeon, after passing the catheter along the urethra as far as the prostate, will find it necessary to guide the point of the instrument into the bladder by the finger introduced into the bowel. The middle or third lobe of the prostate being enlarged, bends the prostatic part of the urethra upwards. But when either of the lateral lobes is enlarged, the urethra becomes bent towards the opposite side.

By dividing the levator ani muscle, K K, on both sides of the rectum, R, Fig. 4, and detaching and depressing this from the perinæal centre, the prostate, N N, and base of the bladder, O, are brought into view. The pelvic fascia may be now felt reflected from the inner surface of the levator ani muscle to the bladder at a level corresponding with the base of the prostate, and the neck of the bladder in front, and the vesiculæ seminales, P P, laterally. In this manner the pelvic fascia serves to insulate the perinæal space from the pelvic cavity. The prostate occupies the centre of the perinæum. If the perinæum were to be penetrated at a point midway between the bulb of the urethra and the anus, and to the depth of two inches straight backwards, the instrument would transfix the apex of the prostate. Its left lobe lies directly under the middle of the line of incision which the lithotomist makes through the surface; a fibrous membrane forms a capsule for the gland, and renders its surface tough and unyielding, but its proper substance is friable, and may be lacerated or dilated with ease, after having partly incised its fibrous envelope. The membranous part of the urethra, M, Fig. 4, enters the apex of the prostate, and traverses this body in a line, nearer to its upper than to its under surface; and that portion of the canal which the gland surrounds is named prostatic. The prostate is separated from the pudic artery by the levator ani muscle, and from the artery of the bulb, by that muscle, the deep perinæal fascia, and the muscular fibres enclosed between its two layers.

The prostate being a median structure, is formed of two lobes, united at the median line. The bulbus urethræ being also a median structure, is occasionally found notched in the centre, and presenting a bifid appearance. On the base of the bladder, O, Fig. 4, the two vasa deferentia, Q Q, are seen to converge from behind forwards, and to enter the base of the gland; a triangular interval is thus formed between the vasa, narrower before than behind, and at the middle of this place it will be observed that the point of the trocar may be passed (through the rectum), for the purpose of evacuating the contents of the bladder, when other measures fail. When this operation is required to be performed, the situation of the prostate is first to be ascertained through the bowel; and at a distance of an inch behind the posterior border of the gland, precisely in the median line, the distended base of the bladder may be safely punctured. If the trocar pierce the bladder at this point, or if an incision exactly *median* were to be made through the membranous urethra, through the prostate, and the base of the bladder, the seminal vessels converging to the prostate from either side, and the recto-vesical serous pouch behind, will escape being wounded. But such incision is prevented by the apposition of those parts and the rectum. On the other hand, it is evident, that by incising the prostate through its left lobe *obliquely*, in order to leave the rectum intact, the seminal vessels are endangered; and, judging from their position, it would appear to me that they are always injured in lithotomy. If the prostate happen to be much enlarged, the relative position of the neighbouring parts will be found disturbed, and in such case the bladder can be punctured above the pubes with greater ease and safety. In cases of *impassable* stricture, when extravasation of urine is threatened, or has already occurred, the urethra should be opened in the perinæum behind the place where the stricture is situated, and this (in the present instance) certainly seems to be the more effectual measure, for at the same time that the stricture may be divided, the contents of the bladder may be evacuated through the perinæum. If the membranous part of the urethra be that where the stricture exists, a staff with a central groove is to be passed as far as the strictured part, and having ascertained the position of the instrument by the finger in the bowel, the perinæum should be incised, at the middle line, between the bulb of the urethra and the anus. The urethra in this situation will be found to curve backwards at the depth of an inch or more from the surface. The point of the staff is to be felt for, and the urethra is to be incised upon it. The bistoury is next to be carried backwards through the stricture till it enters that part of the urethra (usually dilated in such cases) which intervenes between the seat of obstruction and the neck of the bladder.

The lateral operation of lithotomy is to be performed according to the above-described anatomical relations of the parts concerned. The following is the mode of operation usually followed:

The bowel being empty and the bladder moderately full, a staff with a groove in its left side is to be passed by the urethra into the bladder. The position and size of the prostate is next to be ascertained by the left forefinger in the rectum. Having now explored the surface of the perinæum in order to determine the situation of the left tuberosity and ischio-pubic ramus, in relation to the perinæal middle line, the staff being held steadily against the symphysis pubis, the operator proceeds to divide the skin and superficial fascia on the left side of the perinæum, commencing the incision on the left of the raphè, about an inch in front of the anus, and carrying it downwards and outwards midway between the anus and ischiatic tuberosity, to a point below these parts. The left forefinger is then to be passed along the incision for the purpose of parting the loose cellular tissue; and any of the more resisting structures, such as the fasciæ, the transverse and levator ani muscles, are to be divided by the knife. Deep in the forepart of the wound, the position of the staff is next to be felt for, and the structures which cover the membranous portion of the urethra are to be cautiously divided. Recollecting now that the artery of the bulb passes anterior to the staff in the urethra, on a level with the bulb, the vessel is to be avoided by inserting the point of the knife in the groove of the staff as far backwards —that is, as near the apex of the prostate—as possible. The point of the knife having been inserted in the groove of the staff, the bowel is then to be depressed by the left forefinger; and now the knife, with its back to the staff, and its edge lateralized (towards the lower part of the left tuber ischii), is to be pushed steadily along the groove and *deeply*

FIGURES OF PLATE XLIII.

Fig. 1.—A, Accelerator urinæ.—C, Triangular ligament, or deep perinæal fascia.—D D, Crura penis.—E, Pudic artery, and branch to the bulb.—F, Anus.—G, Point of coccyx.—H H, Tubera ischiorum.—J J, Gluttæal muscles.—K K, Levator ani muscles.—L L, Sacro-sciatic ligaments.—M, Perinæal tendinous centre.

Fig. 2.—Other parts marked as in Fig. 1.—A, Urethra.—B B, Its bilobed bulb.—C*C C, Layers of deep perinæal fascia with Cowper's glands between them.

Fig. 3.—Other parts marked as in Fig. 2.—A B, Urethra cut and turned aside.—D D, Crura penis cut.—K K, Levator ani cut.—M, Section of membranous urethra.—R, Rectum.

Fig. 4.—Other parts marked as in Fig. 3.—N N, Right and left lobes of the prostate.—O, Base of the bladder.—P, Vesiculæ seminales.—Q Q, Vasa deferentia.—R, Rectum turned down.

in the direction of the staff, and made to divide the membranous part of the urethra and the anterior two-thirds of the left lobe of the prostate. The gland must necessarily be divided to this extent if the part of the urethra which it surrounds be traversed by the knife. The extent to which the prostate will be divided depends upon the degree of the angle which the knife, passing along the urethra, makes with the staff. The greater this angle is, the greater the extent to which the gland will be incised. The knife being next withdrawn, the left forefinger is to be passed through the opening into the bladder, and the parts are to be dilated by the finger as it proceeds, guided by the staff. The staff is now to be removed while the point of the finger is in the neck of the bladder, and the forceps is to be passed into the bladder along the finger as a guide. The calculus, now in the gripe of the forceps, is to be extracted by a slow undulating motion.

The general rules recommended to be adopted in performing the operation of lithotomy are as follow:—1st, The incision through the skin and sub-cutaneous cellular membrane should be freely made, in order that the stone may be easily extracted and the urine have ready egress. The incision which (judging from the anatomical relations of the parts) appears to be best calculated to effect these objects, is one which would extend from a point an inch above the anus to a point in the posterior perinæal space an inch or more below the anus. The wound thus made would *depend in relation to the neck of the bladder;* the important parts, vessels, &c., in the anterior perinæal space would be avoided where the incision, if extended upwards, would have no effect whatever in facilitating the extraction of the stone or the egress of the urine; and what is also of prime importance, the external opening would directly correspond with the incision through the prostate and neck of the bladder. 2nd, After the incision through the skin and superficial fascia is made, the operator should separate as many of the deeper structures as will admit of it, by the finger rather than by the knife; and especially should use the knife cautiously towards the extremities of the wound, so as to avoid the artery of the bulb, and the bulb itself in the upper part, and the rectum below. The pudic artery will not be endangered if the deeper parts be divided by the knife, with its edge directed downwards and outwards, while its point slides securely along the staff in the prostate. But it needs scarcely to be observed that a serious hæmorrhage will be inevitable and caused by no error of judgment, if the artery of the bulb arise opposite the anus,—or if the inferior hæmorrhoidal arteries be larger than usual,—or if the pudic artery itself course towards the median line, or in contact with the left lobe of the prostate, for either would cross the line of incision, or if the prostate be surrounded by a plexus of enlarged veins. 3rd, The prostate should be incised sparingly, for, in addition to the known fact that the gland when only partly cut admits of dilatation to a degree sufficient to admit the passage of even a stone of large size; it is also stated upon high authority, that by incising the prostate and neck of the bladder to a length equal to the diameter of the stone, such a proceeding is more frequently followed with disastrous results, owing to the circumstance that the pelvic fascia being divided at the place where it is reflected upon the base of the gland and the side and neck of the bladder, allows the urine to infiltrate the cellular tissue of the pelvis.* When the calculus is large, it is recommended to divide the prostate by an incision combined of the transverse and the lateral; the advantages gained by such a combination (by notching the right lobe of the prostate also) being said to be, that the sides of both sections are thereby rendered more readily separable, so as to suit with the rounded form of the body to be extracted.

The position in which the staff is held while the membranous urethra and prostate are being divided, should be regulated by the operator himself. If he requires the perinæum to be protruded and the urethra directed towards the place of the incision, he can effect this by depressing the handle of the instrument a little towards the right groin, taking care at the same time that the point is kept beyond the prostate in the interior of the bladder.

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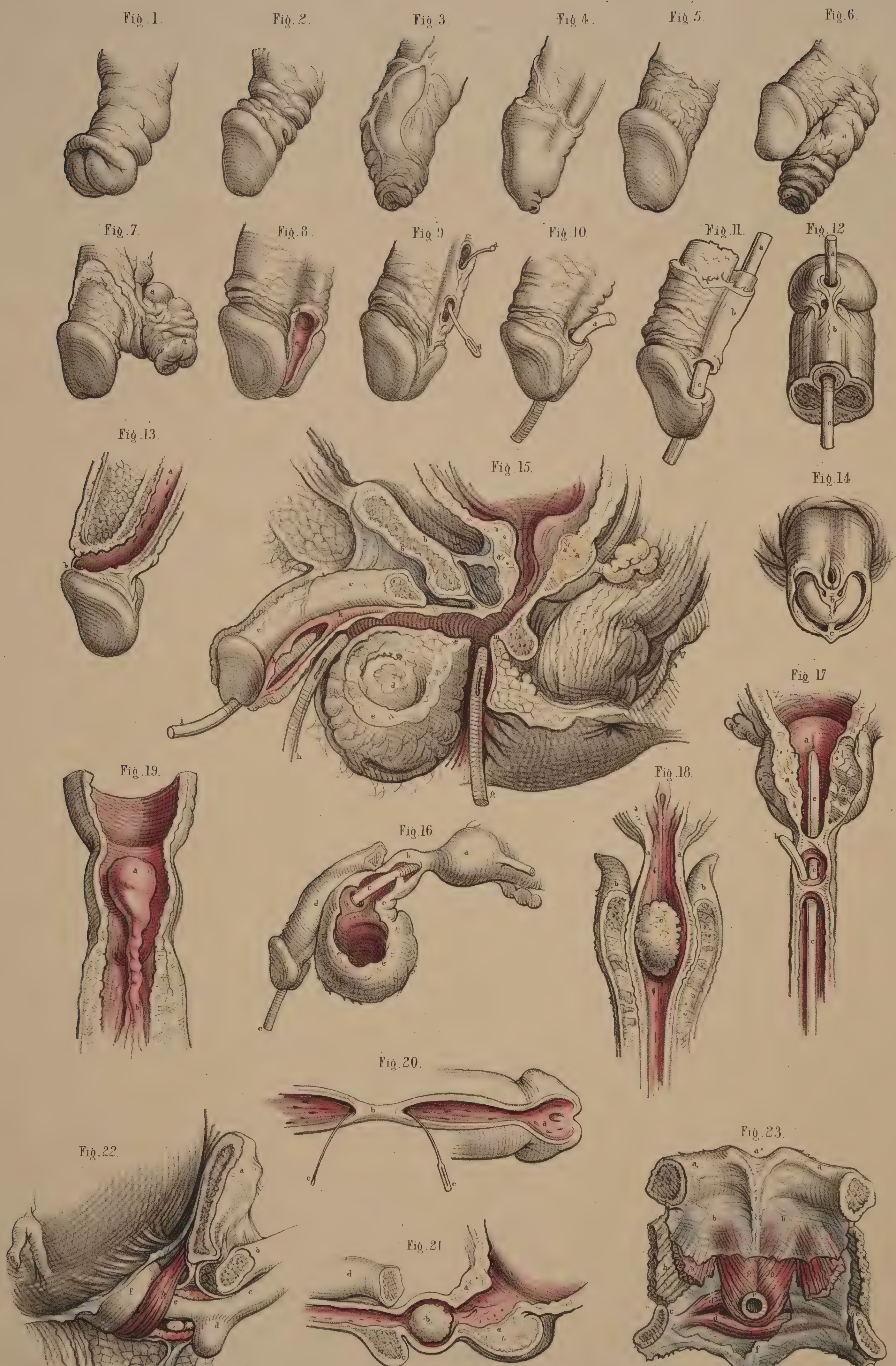
* "The object in following this method," Mr. Liston observes, "is to avoid all interference with the reflexion of the ilio-vesical fascia from the sides of the pelvic cavity over the base of the gland and side of the bladder. If this natural boundary betwixt the external and internal cellular tissue is broken up, there is scarcely a possibility of preventing infiltration of the urine, which must almost certainly prove fatal. The prostate and other parts around the neck of the bladder are very elastic and yielding, so that without much solution of their continuity, and without the least laceration, the opening can be so dilated as to admit the forefinger readily through the same wound; the forceps can be introduced upon this as a guide, and they can also be removed along with a stone of considerable dimensions, say from three to nearly five inches in circumference, in one direction, and from four to six in the largest."—*Practical Surgery*, page 510. This doctrine (founded, no doubt, on Mr. Liston's own great experience) coincides with that first expressed by Scarpa, Le Cat, and others. Sir Benjamin Brodie, Mr. Stanley, and Mr. Syme are also advocates for limited incisions, extending no farther than a partial division of the prostate, the rest being effected by dilatation. The experience, however, of Cheselden, Martineau, and Mr. S. Cooper, inclined them in favour of a rather free incision of the prostate and neck of the bladder proportioned to the size of the calculus, so that this may be extracted freely, without lacerating or contusing the parts, "and," says the distinguished lithotomist Klein, "upon this basis rests the success of my operations; and hence I invariably make it a rule to let the incision be rather too large than too small, and never to dilate it with any blunt instrument when it happens to be too diminutive, but to enlarge it with a knife, introduced, if necessary, several times."—*Practische Ansichten der Bedeutendsten Chirurgische Operationen.* As to the mode in which the superficial and deep incisions in lateral lithotomy should be made, Mr. Fergusson remarks, "a free incision of the skin I consider a most important feature in the operation; but beyond this the application of the knife should, in my opinion, be extremely limited. In so far as I can perceive, there should be no hesitation in cutting any part of the gland which seems to offer resistance, with the exception, perhaps, of its under surface, where the position of the seminal ducts, and other circumstances, should deter the surgeon from using a cutting instrument."—*Practical Surgery*, p. 643. Opinions of the highest authority being thus opposed, in reference to the question whether free or limited incisions in the neck of the bladder are followed respectively by the greater number of fatal or favourable results, and these being thought mainly to depend upon whether the pelvic fascia be opened or not, one need not hesitate to conclude, that since facts seem to be noticed in support of both modes of practice equally, the issue of the cases themselves must really be dependent upon other circumstances, such as the state of the constitution, the state of the bladder, and the relative position of the internal and external incisions. "Some individuals (observes Sir B. Brodie) are good subjects for the operation, and recover perhaps without a bad symptom, although the operation may have been very indifferently performed. Others may be truly said to be bad subjects, and die, even though the operation be performed in the most perfect manner. What is it that constitutes the essential difference between these two classes of cases? It is, according to my experience, the presence or absence of organic disease."—*Diseases of the Urinary Organs.*

PL. XLIV.



M & N Hanhart, Imp.

COMMENTARY ON PLATE XLIV.

CONGENITAL AND PATHOLOGICAL DEFORMITIES OF THE PREPUCE AND URETHRA.—STRICTURE AND MECHANICAL OBSTRUCTIONS OF THE URETHRA.

When any of the central organs of the body presents itself in a form differing from that which we term *natural*, or structurally perfect and functionally efficient, we have to inquire if it be a congenital or pathological effect with a view to the possibility of remedial measures; for in the former case the state of the parts is generally such that the peculiarity of conformation takes place to the total absence of the natural, and is therefore beyond the pale of art; whereas in the latter case, both conditions—the abnormal and the normal—may co-exist, and the worse condition be made at choice to succumb to the better. If the deformity be one which results as a malformation, ascribable to an error in the law of development, it is always characterized as an excess or defect of the substance of the organ at, and in reference to, the median line. And when any of the canals which naturally open upon the external surface at the median line happens to deviate from its proper position, such deviation, if it be the result of an error in the law of development, always occurs, by an actual necessity, at the median line. On the contrary, though deformities which are the results of diseased action in a central organ may and do, in some instances, simulate those which occur by an error in the process of development, the former cannot bear a like interpretation with the latter, for those are the effects of ever-varying circumstances, whereas these are the effects of certain deviations in a natural process—a law whose course is serial, gradational, and in the sequent order of a continuous chain of cause and effect.

Figure 1 represents the prepuce of an adult in a state of congenital phymosis. The part hypertrophied and pendent projects nearly an inch in front of the meatus, and forms a canal, continued forwards from this orifice. In infancy the prepuce is naturally, in some degree, in a state of phymosis, but in the advance of years it assumes its capability of retraction. When, however, the part at any period of life presents the character of the Figure referred to, it may be regarded as a malformation. As the prepuce in such a state becomes devoid of its proper function, and hence must be regarded, not only as a mere superfluity, but as a cause of impediment to the generative function of the whole organ, it should be removed by an operation; the best mode of conducting which proceeding at once suggests itself, viz., that of a circular amputation of the part.

Figure 2 represents the prepuce in the condition of paraphymosis following gonorrhœal inflammation. The part appears constricting the penis and urethra behind the corona glandis. This state of the organ is produced in the following-mentioned way:—the prepuce, naturally very extensible, becomes, while covering the glans, inflamed, thickened, and its orifice contracted. It is during this state withdrawn forcibly backwards over the glans, and in this situation, while being itself the first cause of constriction, it induces another—namely, an arrest to the venous circulation, which is followed by a turgescence of the glans. In the treatment of such a case, the indication is, first, to reduce by gradual pressure the size of the glans, so that the prepuce may be replaced over it; secondly, to lessen the inflammation by the ordinary means; and, thirdly, if the preputial orifice remain unnaturally contracted by an inextensile ring of new deposit, to remove this part by a circular incision. If it were found impossible to reduce the prepuce from behind the glans to its natural position, the constricting band should be liberated by an incision.

Figure 3 exhibits the form of a gonorrhœal phymosis. The orifice of the prepuce is contracted, the veins are swollen, and the tissue of it infiltrated. If in this state of the part, consequent upon diseased action, or in that of Fig. 1, which is congenital, the foreskin be retracted over the glans, a paraphymosis, like Fig. 2, will be produced. As a gonorrhœal or a chancrous phymosis is the result of inflammation, the increase of the prepuce, and the contraction of its orifice, being due to serous infiltration; its treatment should be antiphlogistic and persevered in, in the hopes of rendering unnecessary that most uncouth of all operations in surgery—a longitudinal division of the prepuce, which ultimately proves such an impediment as to require amputation.

Figure 4 shows a form of phymosis in which the prepuce during inflammation has become adherent to the whole surface of the glans. The orifice of the prepuce being directly opposite the meatus, and the parts offering no obstruction to the flow of urine, an operation for separating the prepuce from the glans would not be required for that end, and for any other would be an ineffectual and difficult measure, and for these reasons inadmissible.

Figure 5.—In this figure is represented the form of the penis of an adult, in whom the prepuce was removed by circumcision at an early age according to the Jewish rite. The membrane covering the glans and the part which is cicatrised becomes in these cases dry, indurated, and deprived of its special sense—a result which illustrates the physiological use of the prepuce.

Figure 6.—In this figure the glans appears protruding through the upper surface of the prepuce, *a a*, which is thickened and corrugated. This state of the parts was caused by a venereal ulceration of the upper part of the prepuce, sufficient to allow the glans to press through the aperture. The prepuce in this condition being superfluous, wholly useless as an excrescence, and acting as an impediment, should be removed by operation.

Figure 7.—In this figure is shown a condition of the glans and prepuce, *a a*, resembling that last mentioned, and the effect of a similar cause. By the removal of the prepuce when in the position here represented, or in that of Fig. 6, the organ may be made to assume the appearance of Fig. 5.

Figure 8 represents the form of a congenital hypospadias in the adult. The corpus spongiosum, *a a*, does not continue the canal of the urethra as far forwards as the usual position of the meatus, but has become defective behind the frænum præputii, leaving the canal open at this place. In a case of this kind might an operation on the Taliacotian principle be tried, in order to close the urethra where it presents abnormally patent?

Figure 9 represents a congenital hypospadias, in which the canal of the urethra opens by two distinct apertures along the under surface of the corpus spongiosum at the middle line. A probe, *a a*, traverses both apertures. In such a case, if the canal of the urethra were perforate as far forwards as the meatus, and this latter in its normal position, the two false openings should, if possible, be closed by an operation. In this instance the meatus and adjacent part of the urethral canal were imperforate. This Figure and Fig. 8 are as arrests in the process of median union as respects the urethra, which part, in the early fœtal condition, is dehiscent throughout its whole length along its inferior median line.

Figure 10.—The urethra is here represented as having a false opening on its under surface behind the frænum. The perforation was caused by a venereal ulcer. The meatus and urethra anterior to the false aperture remained perforate. Part of a bougie, *a*, appears traversing the false opening and the meatus. In this state of the organ an attempt should be made to close the false aperture permanently.

Figure 11 shows a state of the urethra similar to that of Fig. 10, and the effect of the same cause. Part of a bougie, *a*, is seen traversing the false aperture, *c*, from the meatus before to the urethra, *b*, behind. In this case, as the whole substance of the corpus spongiosum was destroyed for half an inch in extent, the Taliacotian operation, by which lost quantity is supplied, is the measure most likely to succeed in closing the canal.

Figure 12.—Behind the meatus, and on the right of the frænum, is represented a perforation in the urethra, caused by a venereal ulcer. The meatus and the false opening have approached each other by the contraction of the cicatrix; in consequence of which, also, the apex of the glans is distorted towards the urethra; a bougie, *a*, *c*, introduced by the meatus occupies the urethral canal, *b*.

Figure 13.—In this figure the canal of the urethra, *a*, appears turning upwards and opening at the median line behind the corona glandis, *b*. This state of the urethra was supposed to be caused by a venereal ulcer (?) penetrating the canal from the dorsum of the penis. The proper direction of the canal might be restored by obliterating the false passage, provided the urethra remained perforate in the direction of the meatus. Instances of this nature are congenital.

Figure 14 exhibits the form of a congenital epispadias, in which the

urethra, *a*, is seen to open on the dorsal surface of the prepuce at the median line, *b*. The glans appears cleft and deformed. The meatus is deficient at its usual place, *c*. The prepuce at the dorsum is in part deficient, and bound to the glans around the abnormal orifice.

FIGURE 15 represents in section a state of the parts in which the urethra opened externally by one fistulous aperture, *g*, behind the scrotum; and by another, *h*, in front of the scrotum. At the latter place the canal, *k*, beneath the penis became imperforate for an inch in extent. Parts of catheters are seen to enter the urethra through the fistulous openings, *h g;* and another instrument, *i*, is seen to pass by the proper meatus into the urethra as far as the point where this portion of the canal fails to communicate with the other. The under part of the scrotum, *e e*, presents a cleft at the raphè corresponding with the situation of the scrotal septum. This state of the urinary passage may be the effect either of congenital deficiency or of disease. When caused by disease, the chief features in its history, taking these in the order of their occurrence, are, 1st, a stricture in the anterior part of the urethra; 2ndly, a rupture of this canal behind the stricture; 3rdly, the formation (on an abscess opening externally) of a fistulous communication between the canal and the surface of some part of the perinæum; 4thly, the habitual escape of the urine by the false aperture; 5thly, the obliteration of the canal to a greater or less extent anterior to the stricture; 6thly, the parts situated near the urethral fistula become so consolidated and confused that it is difficult in some, and impossible in many cases to find the situation of the urethra, either by external examination or by means of the catheter passed into the canal. The original seat of the stricture becomes so masked by the surrounding disease—and the stricture itself, even if found by any chance, is generally of so impassable a kind—that it must be confessed there are few operations in surgery more irksome to a looker-on than is the fruitless effort made, in such a state of the parts, by a hand without a guide, to pass perforce a blunt-pointed instrument like a catheter into the bladder. In some instances the stricture is slightly pervious, the urine passing in small quantity by the meatus. In others, the stricture is rendered wholly imperforate, and the canal either contracted or nearly obliterated anteriorly through disuse. Of these two conditions, the first is that in which catheterism may be tried with any reasonable hope of passing the instrument into the bladder. In the latter state, catheterism is useless, and the only means whereby the urethra may be rendered pervious in the proper direction, is that of incising the stricture (on a grooved instrument) from the perinæum, and after passing a catheter across the divided part into the bladder, to retain the instrument in this situation till the wound and the fistulæ heal and close under the treatment proper for this end.

FIGURE 16.—In this figure the urethra, *c b*, appears communicating with a sac, *e e e*, like a scrotum. A bougie, *c*, is represented entering by the meatus, traversing the upper part of the sac, and passing into the membranous part, *b*, of the urethra beyond. This case, which was owing to a congenital malformation of the urethra, exhibits a dilatation of the canal such as might be produced behind a stricture, wherever situated. The urine, impelled forcibly by the whole action of the abdominal muscles against the obstructing part, dilates the urethra behind the stricture, and by a repetition of such force the part gradually yields more and more, till it attains a very large size, and protrudes at the perinæum as a distinct fluctuating tumour, every time that an effort is made to void the bladder. If the stricture in such a case happen to cause a complete retention of urine, and that a catheter cannot be passed into the bladder, the tumour should be punctured prior to taking measures for the removal of the stricture.

FIGURE 17 represents two close strictures of the urethra, one of which is situated at the bulb, and the other at the adjoining membranous part. These are the two situations in which strictures of the organic kind are said most frequently to occur (Hunter, Home, Cooper, Brodie, Phillips, Velpeau). False passages, likewise, are mentioned as more liable to be made in these places than elsewhere in the urethral canal. These occurrences—the disease and the accident—would seem to follow each other closely, like cause and consequence. The frequency with which false passages occur in this situation appears to me to be chiefly owing to the anatomical fact, that the part of the urethra at and close to the bulb is the most dependent part of the curve, N M F, Fig. 6, Plate XLI., and hence, that points of instruments descending to this part from before push forcibly against the urethra, and are more apt to protrude through it than to have their points turned upwards and backwards, so as to ascend the curve towards the neck of the bladder. If it be also true that strictures happen here more frequently than elsewhere, this circumstance will of course favour the accident. An additional cause why the catheter happens to be frequently arrested at this situation and to perforate the canal, is owing to the fact, that the triangular ligament is liable to oppose it, the urethral opening in this structure not happening to coincide with the direction of the point, *b*, of the instrument. In the Figure, part of a bougie, *c c c*, traverses the urethra through both strictures and lodges upon the enlarged prostate, *a a a*. Another instrument, *b*, after entering the foremost stricture, occupies a false passage which was made in the canal between the two constricted parts.

FIGURE 18.—A small calculus, *c*, is here represented lodging in the urethra at the bulb. The walls of the urethra around the calculus appear thickened. Behind the obstructing body the canal, *a a*, has become dilated, and, in front of it, contracted. In some instances the calculus presents a perforation through its centre, by which the urine escapes. In others, the urine makes its exit between the calculus and the side of the urethra, which it dilates. In this latter way the foreign body becomes loosened in the canal and gradually pushed forwards as far as the meatus, within which, owing to the narrowness of this aperture, it lodges permanently. If the calculus forms a complete obstruction to the passage of the urine, and its removal cannot be effected by other means, an incision should be made to effect this object.

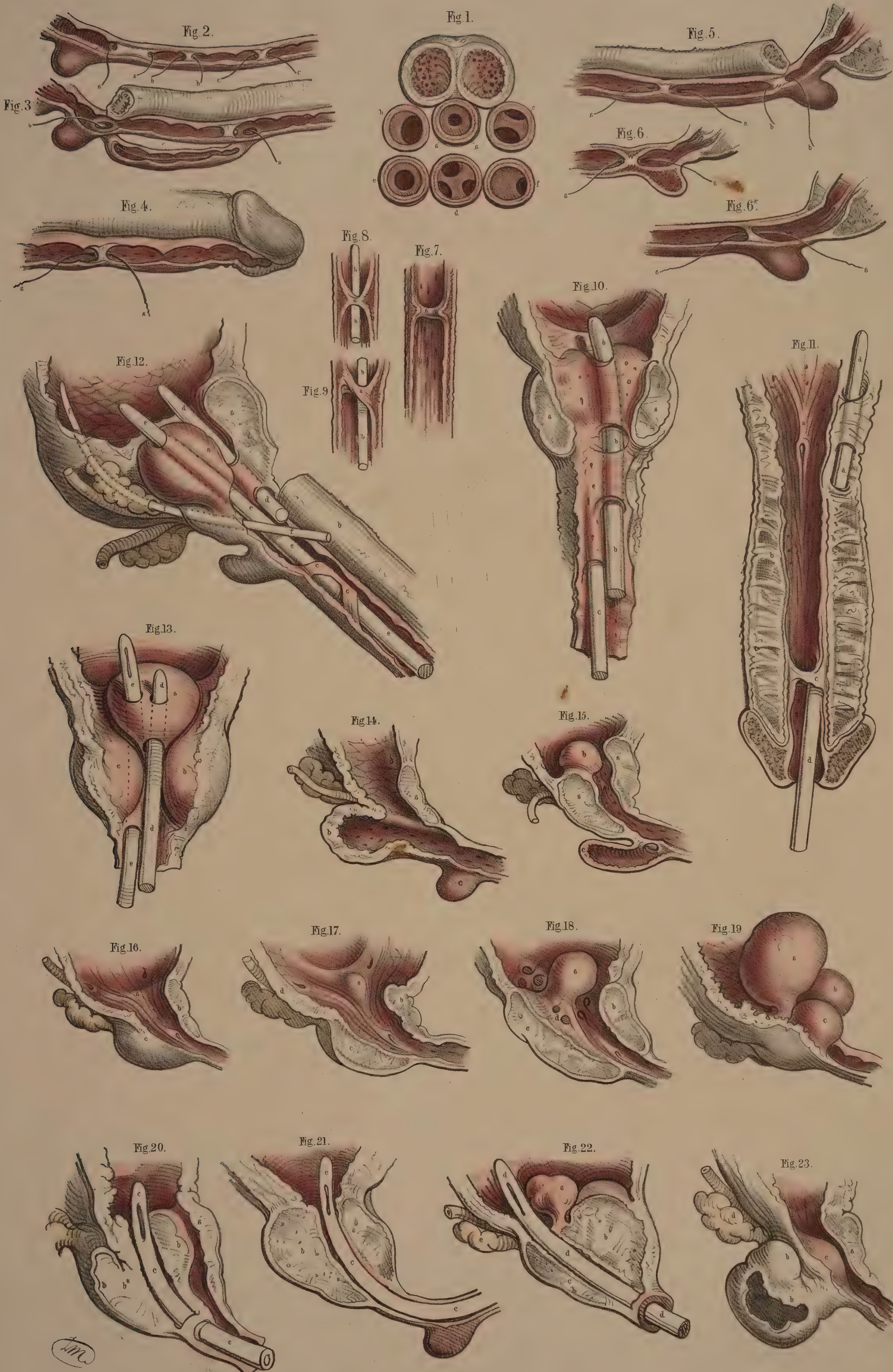
FIGURE 19 represents the neck of the bladder and neighbouring part of the urethra of an ox, in which a polypous growth, *a*, is seen attached by a long pedicle, *b*, to the veru montanum, and blocking up the neck of the bladder. Small irregular tubercles of organized lymph, and tumours formed by the lacunæ distended by their own secretion, their orifices being closed by inflammation, are also found to obstruct the urethral canal.

FIGURE 20 represents the form of an old callous stricture, *b*, half an inch long, situated midway between the bulb and the meatus, *a*. This is perhaps the most common site in which a stricture of this kind is found to exist. In some instances of old neglected cases the corpus spongiosum appears converted into a thick gristly cartilaginous mass, "*several inches in extent*," the passage here being very much contracted, and chiefly so at the middle of the stricture. When it becomes impossible to dilate or pass the canal of such a stricture by the ordinary means, it is recommended to divide the part by the lancetted stilette, but this implies that the stricture is passable. Division of the stricture, by any means, is no doubt the readiest and most effectual measure that can be adopted, provided we know clearly that the cutting instrument engages fairly the part to be divided. But this is a knowledge less likely to be attained if the stricture be situated behind than in front of the triangular ligament.

FIGURE 21.—In this figure is represented a small calculus, *b*, impacted in and dilating the membranous part of the urethra.

FIGURE 22 exhibits a lateral view of the muscular parts which surround the membranous portion of the urethra and the prostate; *e*, the membranous urethra embraced above and beneath by the two parts of the compressor urethræ muscle; *g*, the levator prostatæ muscle; *f*, the prostate; *d*, the bulb; *c*, the corpus spongiosum; *b*, the corpus cavernosum; *a*, the symphysis pubis.

FIGURE 23.—A posterior view of the parts seen in Fig. 22; *e*, the urethra divided in front of the prostate; *g g*, the levator prostatæ muscle, arising from either side of the pubic symphysis behind, and looping under the prostatic urethra; *d d*, the compressor urethræ, arising from the ascending rami, *c c*, of the ischia, and enclosing the urethra between its fibres within the layers of the triangular ligament in front of the levator prostatæ; *h h*, parts of the obturator muscles; *k k*, the anterior fibres of the levator ani muscle; *f*, the triangular ligament enclosing between its layers the artery of the bulb, Cowper's glands, the membranous urethra, and the muscular parts surrounding this portion of the canal; *b b*, the pelvic fascia investing the levator prostatæ and the levator ani; *a a a**, the horizontal rami and symphysis of the pubic bones. The fact that the flow of urine through the urethra happens occasionally to be *suddenly* arrested, and this circumstance contrasted with the opposite fact that the organic stricture is of *slow formation*, originated the idea that the former occurrence arose from a spasmodic muscular contraction. By many this spasm was *supposed* to be due to the urethra being itself muscular. By others, it was *demonstrated* as being dependent upon the muscles which surround the membranous part of the urethra, and which act upon this part and constrict it. From my own observations I have formed the settled opinion that the urethra itself is not muscular. And though, on the one hand, I believe that this canal, *per se*, never causes by active contraction the spasmodic form of stricture, I am far from supposing, on the other, that *all* sudden arrests to the passage of urine through the urethra are solely attributable to spasm of the muscles which embrace this canal.



M & N Hanhart, Imp:

COMMENTARY ON PLATE XLV.

THE VARIOUS FORMS AND POSITIONS OF STRICTURES AND OTHER OBSTRUCTIONS OF THE URETHRA—FALSE PASSAGES, ENLARGEMENTS AND DEFORMITIES OF THE PROSTATE.

Impediments to the passage of the urine through the urethra may arise from different causes, such as the impaction of a small calculus in the canal, or any morbid growth (a polypus, &c.) being situated therein, or from an abscess which, though forming externally to the urethra, may press upon this tube so as either to obstruct it partially, by bending one of its sides towards the other, or completely, by surrounding the canal and compressing it on all sides. These causes of obstruction may happen in any part of the urethra, but there are two others (the prostatic and the spasmodic) which are, owing to anatomical circumstances, necessarily confined to the posterior two-thirds of the canal. The portion of the urethra surrounded by the prostate can alone be obstructed by this body when it has become irregularly enlarged; while the spasmodic stricture can only happen to the membranous portion of the urethra, and to an inch or two of the canal anterior to the bulb,—these being the parts which are embraced by muscular structures. The urethra itself not being muscular (as I believe), cannot, therefore, give rise to the spasmodic form of stricture. But that kind of obstruction which is common to all parts of the urethra, and which is dependent, as well upon the structures of which the duct is uniformly composed, as upon the circumstance that inflammation may attack these in any situation and produce the same effect, is the permanent or organic stricture. Of this disease the forms are as various as the situations are; for as certainly as it may reasonably be supposed that the plastic lymph effused on the mucous surface in an inflamed state of the urethra from any cause, does not give rise to stricture of any special or particular form, exclusive of all others, so, as certainly may it be inferred that, in a structurally uniform canal, inflammation points to no one particular place of it, whereat by preference to establish the organic stricture. The membranous part of the canal is, however, mentioned as being the situation most prone to the disease; but I have little doubt, nevertheless, that owing to general rules of this kind being taken for granted, upon imposing authority, many more serious evils (false passages, &c.) have been effected by catheterism than existed previous to the performance of this operation.

Figures 1, 7, 8, 9.—In these figures are represented various forms of organic stricture occurring in different parts of the urethra. In *a*, Fig. 1, the mucous membrane is thrown into a sharp circular fold, in the centre of which the canal appears much contracted: a section of this stricture appears in *a*, Fig. 8. In *b*, Fig. 1, the canal is contracted laterally by a prominent fold of the mucous membrane at the opposite side. In *c*, Fig. 1, an organized band of lymph is stretched obliquely across the canal: this stricture is seen in section in *a*, Fig. 9. In *d*, Fig. 1, a stellate band of organized lymph, attached by pedicles to three sides of the urethra, divides the canal into three passages. In *f*, Fig. 1, the canal is seen to be much contracted towards the left side by a crescentic fold of the lining membrane projecting from the right. In *e*, Fig. 1, the canal appears contracted by a circular membrane, perforated in the centre; a section of which is seen at *a*, Fig. 7. The form of the organic stricture varies, therefore, according to the three following circumstances:—1st. When lymph becomes effused within the canal upon the surface of the lining mucous membrane, and contracts adhesions across the canal. 2ndly. When lymph is effused external to the lining membrane, and projects this inwards, thereby narrowing the diameter of the canal. 3rdly. When the outer and inner sides of a part of the urethra are involved in the effused organizable matter, and on contracting towards each other, encroach at the same time upon the caliber of the canal. This latter state presents the form which is known as the old callous tough stricture, extending in many instances for an inch or more along the urethra. In cases where the urethra becomes obstructed by tough bands of substance, *c*, *d*, Fig. 1, which cross the canal directly, the points of flexible catheters, especially if these be of slender shape, are apt to be bent upon the resisting part, and on pressure being continued, the operator may be led to suppose that the instrument traverses the stricture, while it is most probably perforating the substance of the urethra. But in those cases where the diameter of the canal is circularly contracted, the stricture generally presents a conical depression in front, which, receiving the point of the instrument, allows this to enter the central passage unerringly. A stricture formed by a crescentic septum, such as is seen in, *b*, *f*, Fig. 1, offers a more effectual obstacle to the passage of a catheter than the circular septum, like, *a*, *c*; for that of the latter kind may be directly entered, while that of the former kind cannot be so if the catheter completely fills the canal of the urethra.

Figure 2.—In this there are seen three separate strictures, *a*, *b*, *c*, situated in the urethra, anterior to the bulb. In some cases there are many more strictures (even to the number of six or seven) situated in various parts of the urethra; and it is observed that when one complete stricture exists, other slight tightnesses in different parts of the canal frequently attend it. (Hunter.) If, however, it is implied by this observation that one stricture is the cause of others, the reason is not obvious. When several strictures occur in various parts of the urethra, they may occasion even more difficulty in passing an instrument than if the whole canal between the extreme constrictions were uniformly narrowed.

Figure 3.—In this the canal is constricted at a point midway between the bulb and glans. A false passage, *c*, has been made under the urethra, subcutaneously, by an instrument which passed out of the canal at the point, *a*, anterior to the stricture, and re-entered the canal at the point, *b*, anterior to the bulb. When a false passage of this kind happens to be made, it will become a permanent outlet for the urine, so long as the stricture remains. For it can be of no avail that we avoid re-opening the anterior perforation by the catheter, so long as the urine, prevented from flowing by the natural canal, enters the posterior perforation. Measures should be at once taken to remove the stricture. A catheter should be passed along the natural canal, if possible, and retained there until, by compression or other means, the false passage be obliterated. But this is a result not in any such case readily attainable, and least so when the false passage is of long standing; for if the urine effused has not, in the first instance, caused inflammation and abscess, followed by the establishment of a fistula, the part, from being frequently and forcibly distended by the fluid, forms a subcutaneous bag, which becomes lined by a kind of mucous membrane, the surfaces of which cannot be easily rendered adherent. An instance of this nature has come under my notice, which, from its large size and form, resembled a scrotum, and contained a calculous deposit.

Figure 4.—The stricture, *a*, appears midway between the bulb and glans, the area of the passage through the stricture being sufficient only to admit a bristle to pass. It would seem almost impossible to pass a catheter through a stricture so close as this, unless by a laceration of the part, combined with dilatation.

Figure 5.—Two strictures are represented here, the one, *b*, close to the bulb, the other, *a*, an inch and a half anterior to this part. In the prostate were seen irregularly-shaped abscess pits, communicating with each other, and projecting upwards the floor of this body to such a degree, that the prostatic canal appeared nearly obliterated.

Figures 6, 6*.—Two strictures are here shown, situated—the one at the bulb, the other immediately in front of it.

Figure 10.—Two instruments, *b*, *c*, have made false passages beneath the mucous membrane, in a case where no stricture at all existed; the resistance which the instruments encountered in passing out of the canal having been mistaken, no doubt, for that of passing through a close stricture. The ducts of the mucous follicles were in this case much dilated, and their orifices very patent; and probably the accident illustrated was owing to the point of a catheter having entered one of them.

Figure 11.—A bougie, *d*, *d*, is seen to perforate the urethra anterior to the stricture, *c*, situated an inch behind the glans, and after traversing the substance of the left corpus cavernosum, *b*, for nearly its whole length, enters the neck of the bladder through the left lobe of the prostate. The whole length of the urethra was in this case inordinately dilated posterior to the stricture. It is remarked that the origin of a false passage is in general anterior to the stricture, wherever situated. It may, however, occur at any part of the canal in which no stricture exists, if the hand that impels the instrument be not guided by a true knowledge of the form of the urethra; and perhaps the accident happening from this cause is the more general rule of the two.

Figure 12.—In this case, an instrument, *e e e*, after passing beneath part of the lining membrane, *c c*, anterior to the bulb, penetrates *a*, the right lobe of the prostate. A second instrument, *d d*, penetrates the left lobe. A third smaller instrument, *f f*, is seen to pass out of the urethra anterior to the prostate, and after transfixing the right vesicula seminalis, *g*, external to the neck of the bladder, enters this viscus at a point behind the prostate. The resistance which the two larger instruments meet with in penetrating the prostate, made it seem, perhaps, that a tight stricture existed in this situation, to match which the smaller instrument, *f f*, was afterwards passed in the course marked out.

Figure 13.—Two instruments appear transfixing the prostate, of which body the three lobes, *a*, *b*, *c*, are much enlarged. The instrument, *d*, perforates the third lobe, *a*, while the instrument, *e*, penetrates the right lobe, *c*, and the third lobe, *a*. This accident occurs when instruments not possessing the proper prostatic bend are forcibly pushed forwards against the resistance at the neck of the bladder. In another case, two bougies were seen to enter the upper wall of the urethra, anterior to the prostate. This accident happens when the handle of a rigid curved instrument is depressed too soon, with the object of raising its point over the enlarged third lobe of the prostate.

Figure 14.—The prostate, *a b*, is here represented as thinned in its lobes before and behind. The lower part, *b*, is dilated into a pouch projecting backwards, behind and beneath the neck of the bladder. The pouch was caused by the points of misdirected instruments having been rashly forced against this part of the prostate.

Figure 15.—The prostate, *a a*, is here seen to be somewhat more enlarged than natural. A tubercle, *b*, surmounts the posterior part of it, and blocks up the vesical orifice. Catheters introduced by the urethra for retention of urine caused by the tubercle, have had their points arrested at the bulb, and on being pushed forwards in thi direction, have dilated the bulb into the form of a pouch, *c*. The sinus of the bulb being the lowest part of the curve of the urethra, is therefore very liable to be distorted or perforated by the points of instruments descending upon it from above and before. When a stricture exists immediately behind the bulb, this circumstance will of course favour the occurrence of the accident. Neither in this case, however, nor in that of Fig. 14, did an organic stricture exist.

Figures 16, 17, 18, 19 represent a series of prostates in which the third lobe gradually increases in size. In Fig. 16, which shows the healthy state of the neck of the bladder, unmarked by the prominent lines which are said to bound the space named "trigone vesical," or by those which indicate the position of the "muscles of the ureters," the "third lobe" does not exist. In Fig. 17 the third lobe appears as the uvula vesicæ, *a*. In Fig. 18 the uvula, *a*, is increased, and under the name now of third lobe is seen to contract and bend upwards the prostatic canal. The effect which the growth of the lobe, *a*, produces upon the form of the neck of the bladder becomes more marked, and the part presenting perforations produced by instruments, indicates that by its shape it acted as an obstacle to the egress of the urine as well as to the entrance of instruments. A calculus of irregular form was seen to lodge behind the third lobe, and to be out of the reach of the point of a sound,—supposing this to enter the bladder over the apex of the lobe. In Fig. 19 the three lobes, *a*, *b*, *c*, are enlarged, but the third, *a*, is most so, and while standing on a narrow pedicle attached to the floor of the prostate, completely blocks up the neck of the bladder. On comparing this series of figures, it must appear that the third lobe of the prostate is the product of diseased action, in so far, at least, as an unnatural hypertrophy of a part may be thus designated. It is not proper to the bladder in the healthy state of this organ, and where it does manifest itself by increase it performs no healthy function in the economy. When Home, therefore, described this part as a new fact in anatomy, he had in reality as little reason for so doing as he would have had in naming any other tumour a thing unknown to normal anatomy. Langenbeck (*Neue Bibl.*, b. i. p. 360) denies its existence in the healthy state. Cruveilhier (*Anat. Pathog.*, liv. xxvii.) deems it incorrect to reckon a third lobe as proper to the healthy bladder.

Figure 20.—The prostatic canal, *a b*, is bent upwards by the enlarged third lobe, *b*, to such a degree as to form nearly a right angle with the membranous part of the canal. A catheter, *c c*, is seen to perforate the third lobe, and this is the most frequent mode in which, under such circumstances, and with instruments of the usual imperfect form, access may be gained to the bladder for the relief of retention of urine. "The new passage may in every respect be as efficient as one formed by puncture or incision in any other way." (Fergusson). When a catheter is suspected to have entered the bladder by perforating the prostate, the instrument should be retained in the newly-made passage till such time as this has assumed the cylindrical form of the instrument. If this be done the new passage will be the more likely to become permanent. It is ascertained that all false passages, and fistulæ, by which the urine escapes, become after a time lined with a membrane similar to that of the urethra.

Figure 21.—The prostatic lobes, *a*, *b*, are uniformly enlarged, and cause the corresponding part of the urethra to be uniformly contracted, so as closely to embrace the catheter, *c c*, occupying it, and to offer considerable resistance to the passage of the instrument.

Figure 22.—The prostate, *b c*, is considerably enlarged anteriorly, *b*, in consequence of which the prostatic canal appears even more horizontal than natural. The catheter, *d*, occupying the canal, lies nearly straight. The lower part, *c*, of the prostate is much diminished in thickness. A nipple-shaped process, *a*, is seen to be attached by a pedicle to the back of the upper part, *b*, of the prostate, and to act like a stopper to the neck of the bladder. The body, *a*, being moveable, it will be perceived how, while the bladder is distended with urine, the pressure from above may block up the neck of the organ with this part, and thus cause complete retention, which, on the introduction of a catheter, becomes readily relieved by the instrument pushing the obstructing body aside. In a case of this nature, if the condition of the parts were ascertainable, would an operation, as that of lithotomy, be admissible? I have no hesitation in putting this question under the consideration—1st, that an enlarged prostate is not a malignant growth; and hence that if the obstructing part of it were removed, the reduction of its size may remain permanent; 2nd, that the part is no less surgically accessible than a calculus in the bladder, and, anatomically viewed, would require an incision even somewhat less likely to endanger important structures; 3rd, that the distress occasioned by such a tumour is as great as that arising from the presence of a calculus; and both are proved by all experience to be equally unsusceptible of removal by any known kind of medical or surgical treatment. On these grounds I would repeat the question, whether or not certain forms of enlarged prostate, such as are figured in Plates XLV., XLVI., and XLVII., would allow of their surplus parts being extracted by an operation of prostatotomy, as a stone is by lithotomy?

Figure 23.—The right lobe, *c b b*, of the prostate appears hollowed out, so as to form the sac of an abscess which, by its projection behind, *b b*, pressed upon the forepart of the rectum, and by its projection in front, *c*, contracted the area of the prostatic canal, *a c*, and thereby caused an obstruction in this part. Not unfrequently when a catheter is passed along the urethra, for the relief of a retention of urine caused by the swell of an abscess in this situation, the sac becomes penetrated by the instrument, and, instead of urine, pus flows. The sac of a prostatic abscess frequently opens of its own accord into the neighbouring part of the urethra, and when this occurs it becomes necessary to retain a catheter in the neck of the bladder, so as to prevent the urine entering the sac.

Note.—The cause and the exact seat of organic stricture of the urethra are variously stated by pathological anatomists, although its cause and its seat would seem to admit of as little disputation, under the existing evidence of facts, as its effect. Home describes "a natural constriction of the urethra, directly behind the bulb, which is probably formed with a power of contraction to prevent," &c. This is the part which he says is "most liable to the disease of stricture." (*Strictures of the Urethra.*) Now, if any one, even among the acute-observing microscopists, can discern the *contractile* structure to which Home alludes, he will certainly prove this anatomist to be a marked exception to those who, for the enforcement of any doctrine, can see any thing or phenomenon they wish to see. And, if Hunter were as the mirror from which Home's mind was reflected, then the observation must be imputed to the Great Original. Upon the question, however, as to which is the most frequent seat of stricture, I find that both these anatomists do not agree, Hunter stating that its usual seat is just in front of the bulb, while Home regrets, as it were, to be obliged to differ from "his immortal friend," and avers its seat to be an infinitesimal degree behind the bulb. Sir A. Cooper again, though arguing that the most usual situation of stricture is that mentioned by Hunter, names, as next in order of frequency, strictures of the membranous and prostatic parts of the urethra. "False passages," observes Mr. Benjamin Phillips, "are less frequent here (in the membranous part of the urethra) than in the bulbous portion of the canal. The reason of this must be immediately evident : false passages are ordinarily made in consequence of the difficulty experienced in the endeavour to pass an instrument through the strictured portion of the tube. Stricture is most frequently seated at the point of junction between the bulbous and membranous portions of the canal ; consequently, the false passage will be usually anterior to this latter point." (*On the Urethra, its Diseases, &c.*, p. 15.) Such being the subject under dispute, and such the evidence pro and contra, well, indeed, may it be asked, Does it not appear strange how questions of this import should have occupied so much of the serious attention of our great predecessors, and of those, too, who at the present time form the vanguard of the ranks of science? Owing to what circumstance, either anatomical or pathological, can one part of the urethra be more liable to the organic stricture than another? From my own strong suspicions, were the question put to me, I would answer that, if the membranous part is proved by *post-mortem* investigation to be its more usual seat, this is attributable to the fact of that part being more difficult than any other to reach by the point of a catheter, owing to its being situated behind the triangular ligament, and girt by muscular fibres; and that the organic stricture is here less often the cause for, than the effect of, the use of that instrument, whose point not alighting fairly upon the urethral opening of the ligament, and being at the same time resisted by the urethral muscles in spasmodic action against the entry of a foreign body, creates the false idea that an organic stricture must exist, while in truth, it is only now commenced to be formed by the thrusting, bending, contusing, and mangling efforts of a rude ungoverned hand. Such a hand certainly is not his which could "*catheterise the Fallopian tube for sterility.*"

Fig. 1

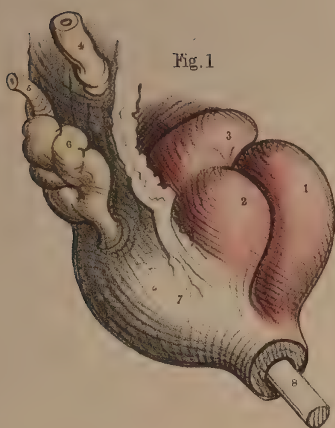


Fig. 2.

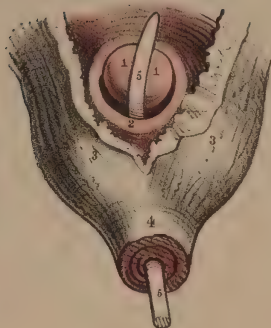


Fig. 3.

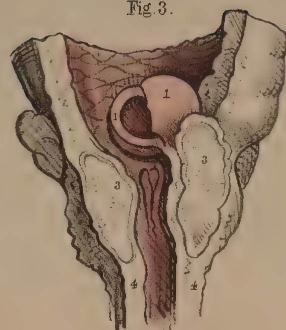


Fig. 4.

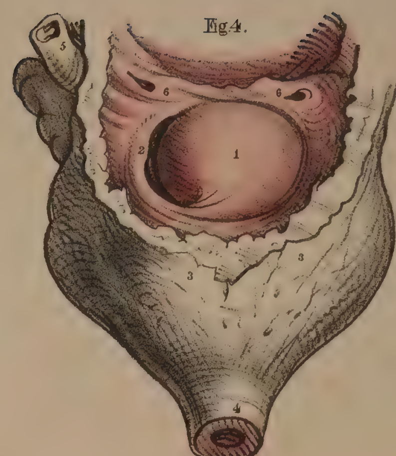


Fig. 5.

Fig. 6.

Fig. 7.

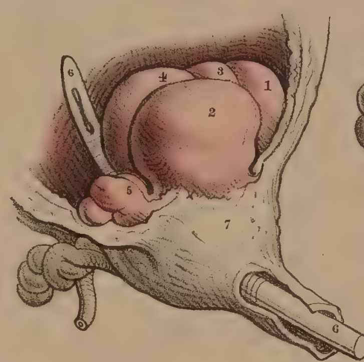


Fig. 8.

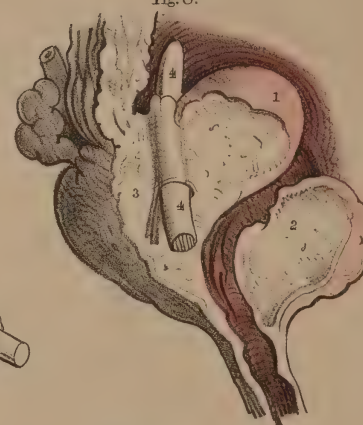


Fig. 9.

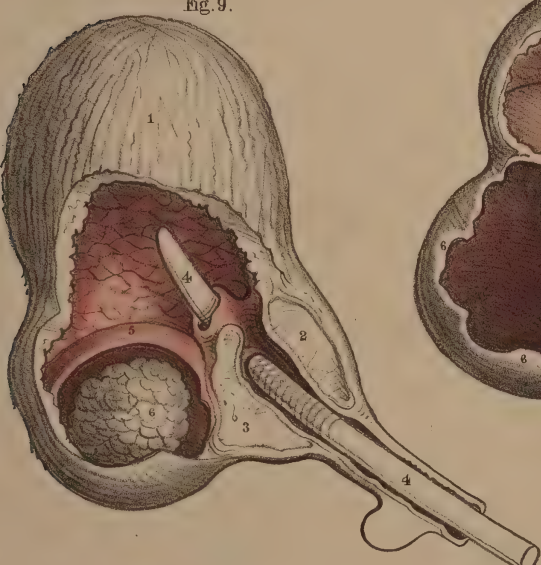


Fig. 10.

Fig. 11.

Fig. 12.

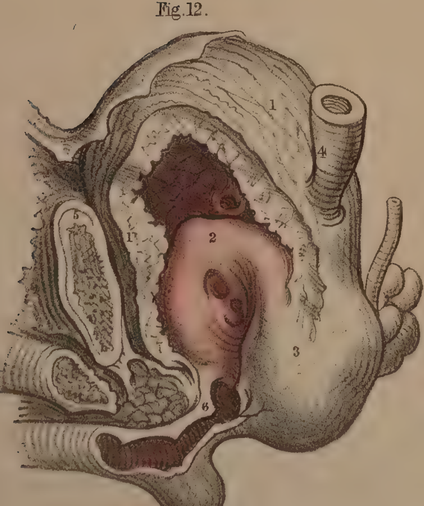


Fig. 13.

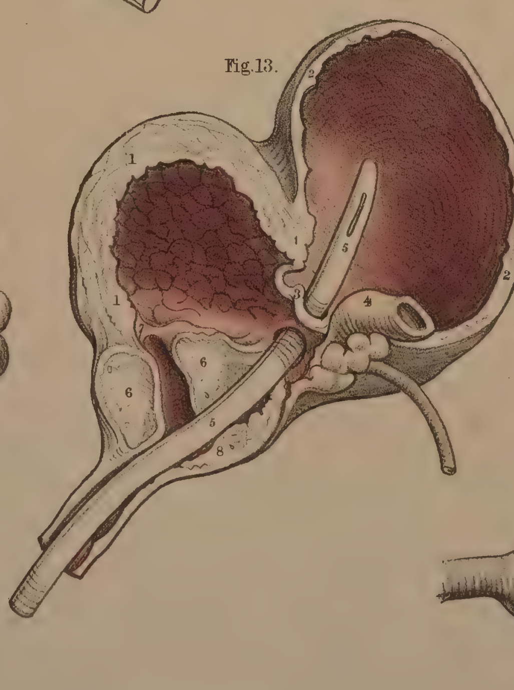


Fig. 14

M & N. Hanhart, Imp.t

COMMENTARY ON PLATE XLVI.

DEFORMITIES OF THE PROSTATE—DISTORTIONS AND OBSTRUCTIONS OF THE PROSTATIC URETHRA.

The prostate is liable to such frequent and varied deformities, the consequence of diseased action, whilst, at the same time, its healthy function (if it have any) in the male body is unknown, that it admits at least of one interpretation which may, according to fact, be given of it—namely, that of playing a principal part in effecting some of the most distressing of "the thousand natural ills that flesh is heir to." But heedless of such a singular explanation of a final cause, the practical surgeon will readily confess the fitting application of the interpretation, such as it is, and rest contented with the proximate facts and proofs. As physiologists, however, it behoves us to look further into nature, and search for the *ultimate fact* in her prime moving law. The prostate is peculiar to the male body, the uterus to the female. With the exception of these two organs there is not another which appears in the one sex but has its analogue in the opposite sex; and thus these two organs, the prostate and the uterus, appear by exclusion of the rest to approach the test of comparison, by which (as I think) their analogy becomes as fully manifested as that between the two quantities, $a - b$, and $a + b$, the only difference which exists depending upon the subtraction or the addition of the quantity, b. The difference between a prostate and a uterus is simply one of quantity, such as we see existing between the male and the female breast. The prostate is to the uterus absolutely what a rudimentary organ is to its fully developed analogue. The one, as being superfluous, is, in accordance with nature's law of *nihil supervacaneum, nihil frustra*, arrested in its development; and in such a character appears the prostate. This body *is not a gland* any more than is the uterus, but both organs being quantitatively, and hence functionally different, I here once more venture to call down an interpretation of the part from the unfrequented bourne of comparative anatomy, and turning it to lend an interest to the accompanying figures, even with a surgical bearing, I remark that the prostatic or rudimentary uterus, like a germ not wholly blighted, is prone to an occasional sprouting or increase beyond its prescribed normal dimensions—a hypertrophy, in barren imitation, as it were, of gestation.

Figure 1.—The three lobes of the prostate 1, 2, 3, are, equally, much enlarged; and project prominently upwards around the neck of the bladder. They have so contracted and distorted upwards the prostatic canal that an instrument, on being passed into the bladder, has transfixed the third lobe.

Figure 2.—A globular excrescence, 1, 1, appears blocking up the vesical orifice, and giving to this the appearance of a crescentic slit, corresponding to the shape of the obstructing body. The prostate, 3, 3, is enlarged in both its lateral lobes. A small bougie, 5, is placed in the prostatic canal and vesical opening. Examples of prostatic disease of this form are not unfrequent; though in all of them the lateral prostatic lobes are enlarged, it is the nipple-shaped body which is the chief cause of impediment. The vesical orifice is sometimes girt by a prominent ring of prostatic growth, to one border of which the globular mass is attached by a pedicle more or less flexible and exactly fitting the outlet when it is pressed downwards. In other instances the enlarged lateral lobes of the prostate present masses projecting from their adjacent sides, and so fitted the one to the other that they act like a complete valvular apparatus which would become closed the tighter according to the increasing degree of effort made to void the bladder; and, from the form which they give to the prostatic canal, bending it to the right side and to the left, would appear to render it impossible to pass a catheter into the bladder without lacerating or perforating them. In all such cases the normal condition of the bladder is changed: it is either thickened, fasciculated, or sacculated, and the ureters are much dilated.

Figure 3.—A cyst, 1, 1, is seen to grow from the left side of the base of the prostate, 3, and to form an obstruction at the vesical orifice—its pedicle allowing it to be depressed under abdominal action on the contents of the bladder, and to act thus as a plug, closing suddenly the outlet of the organ when the contents of this are being voided.

Figure 4.—A globular mass, 1, of large size, occupies the neck of the bladder, and gives the vesical orifice, 2, a crescentic shape, convex towards the right side. The two lateral lobes of the prostate, 3, 3, are much enlarged. The ureters are dilated, and the walls of the bladder are thickened and fibrous. These rotund excrescences are not instances of an enlarged *third* lobe; they are appendages of one or other of the lateral lobes.

Figure 5.—The three lobes, 1, 2, 3, of the prostate are enlarged and of equal size, moulded against each other in such a way that the prostatic canal and vesical orifice appear as mere clefts between them. The three lobes are encrusted on their vesical surfaces with a thick calcareous deposit. The surface of the third lobe, 1, which has been half denuded of the calcareous crust, 4, in order to show its real character, appeared at first to be a stone impacted in the neck of the bladder, and of such a nature it certainly would seem to the touch, on striking it with the point of a sound or other instrument. In the prostatic urethra is sometimes found a calculus closely impacted; and which would arrest the point of a catheter in the effort to pass this into the bladder, and probably lead to the supposition that the instrument grated against a stone in the interior of the bladder; in which case it might be inferred that, since the urine did not flow through the catheter, no retention of urine (which the position of such a calculus caused) existed. Instances of calculi so situated have been found perforated in the centre, allowing of the egress of the contents of the bladder, and even of the introduction of instruments into the viscus.

Figure 6.—The lateral lobes, 6, 6, of the prostate are irregularly enlarged, and the urinary passage is bent towards the right side, 4, from the membranous portion, 5, which is central. Surmounting the vesical orifice is seen the tuberculated mass, 1, 2, 3, which, being moveable, can be forced against the vesical orifice, and thus produce complete retention of urine. In this case, also, a flexible catheter would be more suitable than a metallic one. In addition to the distortion of the canal upwards and forwards, to the right side or to the left, by an increase of the third lobe or of one or other of the lateral lobes, the canal in some cases appears divided by projecting parts of the prostate into two or three channels of lesser size, through either one or other of which the catheter can only be made with difficulty to enter the bladder, though the urine flows through all three. The length of the prostatic canal is also very liable to a great increase, owing to the growth of a large irregular-shaped mass from the bases of the lateral lobes of the prostate, and projecting into the interior of the bladder. When this is the condition of the part, the prostatic canal becomes much more elongated than natural; and the instrument which is to relieve the retention of urine is required to have a very long curve and to be of a length corresponding with that of the canal. While in some instances we find the prostatic canal divided into one or more channels, in others it presents itself dilated into the form of a wide sac—a condition attributable either to the forcive action of instruments or to the formation of an abscess in the prostate, which from time to time (while a stricture exists in the urethra) receives the urine, under great pressure, and thus becomes dilated.

Figure 7.—The prostate presents four lobes, 1, 2, 3, 4, of nearly equal size. The posterior supernumerary lobes are growths of the lateral lobes. They block up the vesical orifice and prostatic canal, and project high into the bladder, the walls of which are hypertrophied. An instrument, 6, has been made to transfix the lobe, 4. In this case is well illustrated the truth, that both lobes of the prostate are equally liable to chronic enlargement. Home believed the left lobe to be oftener increased in size than the right. Wilson (*On the Male Urinary and Genital Organs*) mentions, in support of an opposite belief, several instances of the enlargement of the right lobe. No reason can, however, be assigned why one lobe should be more prone to hypertrophy than the other, even supposing it to be matter of fact, which it is not. But the observations made by Cruveilhier (*Anat. Pathol.*), that the lobulated projections of the prostate always take place internally at its vesical aspect, is as true as the manner in which he accounts for the fact appears somewhat plausible:—The dense fibrous envelope of the prostate is sufficient to repress its irregular growth externally.

Figure 8.—The prostatic canal, 1, 2, is bent by the enlarged third lobe, 1, upwards and forwards in a direction at a right angle with the membranous part of the urethra. A catheter, 4, failing to follow the canal has perforated, 3, 1, the body of the third lobe.

Figure 9.—The prostatic canal, 3, 2, is constricted and bent upwards by, 3, the third lobe. The bladder, 1, is thickened and fibrous, and its base, 5, is dilated in the form of a sac, which is dependent, and within which a calculus, 6, rests. An instrument, 4, enters the bladder through the third lobe, but does not touch the calculus, owing to the low position of this body.

Figure 10.—Projecting from the base, 3, of the bladder appears a sac, 6, 6, of as large size as that organ itself. In the *bas fond* of the bladder a circular opening, 2, appears leading to the sac which rested against the rectum. In a case of this kind the sac, occupying a lower level than the base of the bladder, will first become the recipient of the urine, and retain this fluid even after the bladder has been evacuated voluntarily or by means of a catheter. If in such a state of the parts retention of urine, from any cause, called for puncturation, it is evident that this operation would be performed with better effect by opening the depending sac through the bowel than the bladder in any other situation.

Figure 11.—The lower half, 2, 4, 6, of the prostate, having become the seat of abscess, appears hollowed out in the form of a sac. This sac is separated from the bladder by a horizontal septum, 2, 2, the original base of the bladder, 1, 2. The prostatic urethra, between 5, 2, has become vertical in respect to the membranous part of the canal, 7, in consequence of the upward pressure of the abscess. The sac opens into the urethra, near the apex of the prostate, at the point 6; and a catheter, 7, 7, 7, passed along the urethra has entered the orifice of the sac, the interior of which the instrument traverses, and the posterior wall of which it perforates. The bladder contains a large calculus, 3. The bladder and sac do not communicate, but the urethra is a canal common to both. In a case of this sort it becomes evident that, although symptoms may strongly indicate either a retention of urine, or the presence of a stone in the bladder, any instrument taking the position and direction of 7, 7, cannot relieve the one or detect the other; and such is the direction in which the instrument must of necessity pass, while the sac presents its orifice more in a line with the membranous part of the urethra than the neck of the bladder is. The sac will intervene between the rectum and the bladder; and on examination of the parts through the bowel, an instrument in the sac will readily be mistaken for being in the bladder, while neither a calculus in the bladder, nor this organ in a state of even extreme distension, can be detected by the touch any more than by the sound or catheter. If, while performing lithotomy in such a state of the parts, the staff occupy the situation of 7, 7, 7, then the knife, following the staff, will open, not the bladder, which contains the stone, but the sac, which, moreover, if it happen to be filled with urine regurgitated from the urethra, will render the deception more complete.

Figure 12.—The prostate, 2, 3, is greatly enlarged, and projects high in the bladder, the walls of the latter, 1, 1, being very much thickened. The ureters, 4, are dilated, and perforations made by instruments are seen in the prostate. The prostatic canal being directed almost vertically, and the neck of the bladder being raised nearly as high as the upper border of the pubic symphysis, it must appear that if a stone rest in the *bas fond* of the bladder, a sound or staff cannot reach the stone, unless by perforating the prostate; and if, while the staff occupies this position, lithotomy be performed, the incisions will not be required to be made of a greater depth than if the prostate were of its ordinary proportions. On the contrary, if the staff happen to have surmounted the prostate, the incision, in order to divide the whole vertical thickness of this body, will require to be made very deeply from the perinæal surface, and this circumstance occasions what is termed a "deep perinæum."

Figure 13.—The prostate, 6, 6, is enlarged, and its middle lobe bends the prostatic canal to an almost vertical position, and narrows the vesical orifice, 7. The bladder 1, 1, is thickened. The ureters, 4, are dilated; and a large sac, 2, 2, projects from the base and back of the bladder, and occupies the recto-vesical fossa. The peritonæum is reflected from the summit of the bladder to that of the sac. The sac, equal in size and capacity to the bladder, communicates with this viscus by a small circular opening, 3, situated between the orifices of the ureters. A catheter, 5, perforates the third lobe, 6, 8, of the prostate, and enters the sac through the base of the bladder, a little below the opening of communication. In such a case, a catheter occupying this position would, while voiding the bladder through the sac, make it seem as if it really traversed the vesical orifice, and that no such deformity as the sac existed. Again, if a stone occupied the bladder, the point of the instrument in the sac could not detect it; whereas, on the contrary, if the stone lay within the sac, the instrument on striking the body here would give the impression as if it lay within the bladder.

Figure 14.—The walls, 1, 1, of the bladder, appear greatly thickened, and the ureters, 2, dilated. The sides, 3, 3, of the prostate are thinned; and in the prostatic canal are two calculi, 4, closely impacted. In such a state of the parts it would be impossible to pass a catheter into the bladder for the relief of a retention of urine, or to introduce a staff as a guide to the knife in lithotomy. If, however, the staff can be passed as far as the situation of the stone, the parts may be held with a sufficient degree of steadiness to enable the operator to incise the prostate upon the stone.

Note.—In venturing, as I have done in the text, to state, under the guide of comparison, my ideas of the signification of the prostatic body as it presents itself in its normal and abnormal conditions, the expressions used will not, I trust, be extended as to their meaning beyond the limits I assign to them. Though I have every reason to believe, that between the prostate of the male and the uterus of the female, the same amount of analogy exists, as between a coccygeal ossicle and the complete vertebral form elsewhere situated in the spinal series, I am as far from regarding the two former to be in all respects structurally or functionally alike, as I am from entertaining the like idea in respect to the two latter. But still I maintain that between a prostate and a uterus, as between a coccygeal bone and a vertebra, the only difference which exists is one of *quantity*, and that hence arises the functional difference. A prostate is part of a uterus, just as a coccygeal bone is part (the centrum) of a vertebra. That this is the absolute signification of the prostate I firmly believe, and were this the proper place, I could prove it in detail, by the infallible rule of analogical reasoning. John Hunter has observed that the use of the prostate was not sufficiently known to enable us to form a judgment of the bad consequences of its diseased state. When the part becomes morbidly enlarged, it acts as a mechanical impediment to the passage of urine from the bladder ; but from this circumstance we cannot reasonably infer that, while of its normal healthy proportions, its special function is to facilitate the egress of the urine,—for the female bladder, though wholly devoid of the prostate, performs its own function perfectly. It appears to me, therefore, that the pressing question should be, not—What is the use of the prostate ? but—Has it any proper function ? If the former question puzzled even the philosophy of Hunter, it was because the latter question must be answered in the negative. The prostate has no function proper to itself, *per se.* It is a thing distinct from the urinary apparatus, and distinct likewise from the generative organs. It may be hypertrophied or atrophied, or changed in texture, or wholly destroyed by abscess, and yet neither of the functions of these two systems of organs will be impaired, if the part while diseased act not as an obstruction to them. In texture the prostrate is similar to an unimpregnated uterus. In form it is, like the uterus, symmetrical. In position it corresponds to the uterus. It is situated between the bladder and the rectum, and only overlaps the anterior part of the neck of the former organ by the thin portions of its lateral lobes, which meet each other in front. The prostate has no ducts proper to itself. Those ducts which are said to belong to it (prostatic ducts) are merely mucous cells, similar to, and in series with, those in other parts of the urethral lining membrane. The seminal ducts evidently do not belong to it. The texture of the prostate is not such as appears in glandular bodies generally. In short, the facts which prove what it is not, prove what it actually is—namely, a uterus arrested in its development, and as a sign of that all-encompassing law in nature, which science expresses by the term "unity in variety ;" which law, I conceive to be archetypal, *plus* quantity subjected to degrading metamorphosis—the lesser quantities being the varieties of form. While the prostate, morphologically compared with the uterus, thus plainly radiates its proper signification, we may readily find in the respective appendages of both bodies, analogies in number, form, and relative position ; and where, as to the two latter particulars, differences exist, we are enabled to appreciate the history of developmental design. It cannot be doubted that the testicle and ovary are analogous bodies, for originally they are subrenal in the loins, deriving their blood-vessels directly from the aorta and vena cava ; and thence they descend, the former to pass through the abdominal rings to the scrotum, the latter into the pelvis. Notwithstanding this difference as to position, we may read the analogies between the following-named parts :—The vas deferens, as represented by the degenerated cord (round ligament) of the ovary—the Fallopian tube as the uncoiled representative of the vesicula seminalis, and as instancing, by its jagged fimbriated end, a disseverment from the uterus, whereby is occasioned that single point in the body at which a mucous joins a serous membrane, and deprives the peritoneum of the character of a shut sac—the round ligament of the uterus as the persistent strengthened representative of the fœtal gubernaculum testis—and the peritonæal process (canal of Nuck) which protrudes with the round ligament, as representing persistently the selfsame condition of the male inguinal canal prior to the descent of the testicle to the scrotum. Of the correctness of this parallelism of parts, I have as strong a conviction as he had of his own physiological truth who saw the analogy between the swimming-bladder of a fish and the human lung. And for that value which (however small) my interpretation of the prostate, as a point of knowledge, has, let it stand. It will last, perhaps, till such time as the microscopists shall discover in the "secretion" of the prostate some species of mannikins, such as may pair with those which they term "spermatozoa." And the same facts which I have mentioned in proof of the prostate not being a gland are those which, as it seems to me, give evidence that the prostate alone is that body between which and the uterus any full character of homology can be reasonably granted to exist. With regard to that little membranous recess described by Morgagni as situated between the prostatic lobes, and opening as the *sinus pocularis* within the sides of the *veru montanum*—and which Weber named *vesica prostatica*, Huschke named *utriculus virilis*, and Ackerman named *uterus cystoides*, as representing the rudimentary uterus in the male,—there would actually appear to be no more licence for so designating the part than there would be for naming the lining membrane of the uterus as the uterus complete. But let us in idea (as occasionally it is in fact) enclose this membranous vesicle between the prostatic lobes, and then consider in how far the homology between a prostate and a uterus is rendered more evident. Then have we not a prostatic interior, as we see the uterine interior, with a similar lining to both organs, and both exhibiting substantial fibrous walls, with the ducts of the respective organs entering them in very much the same relative position ?

Fig. 1.

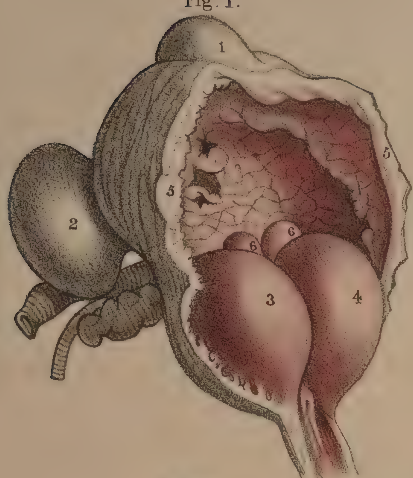


Fig. 2.

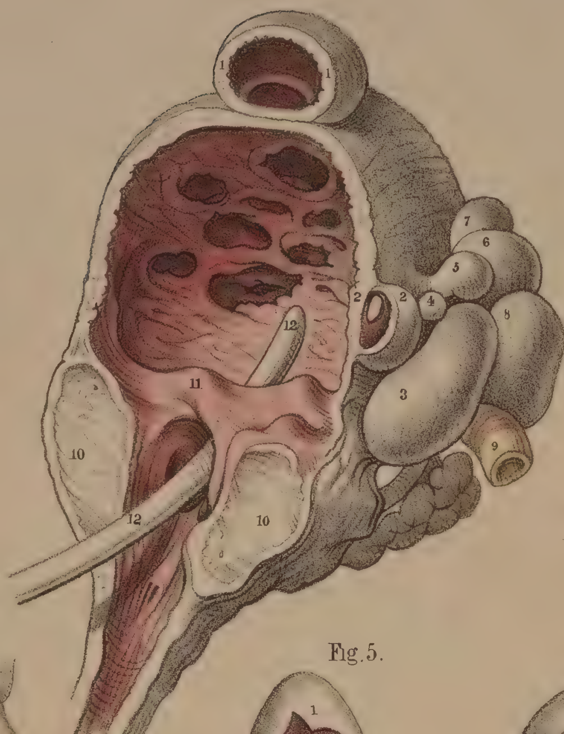


Fig. 3.

Fig. 4

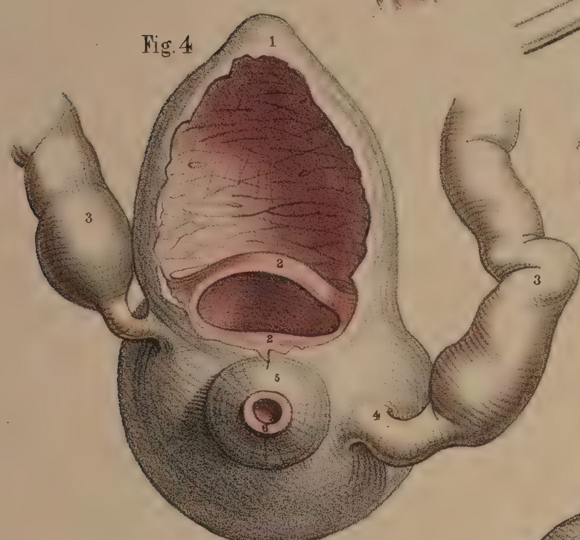


Fig. 5.

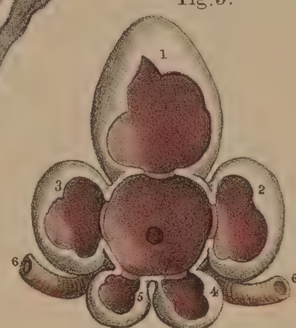


Fig. 6.

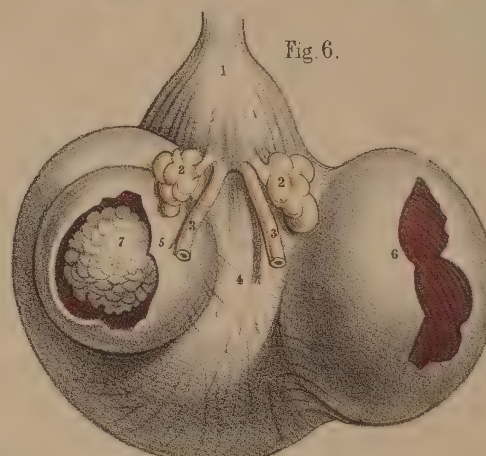


Fig. 7

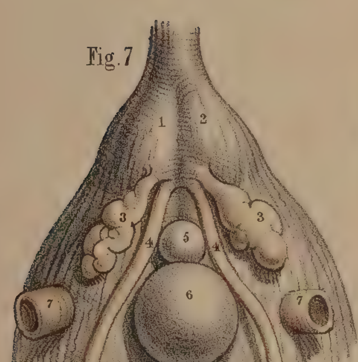


Fig. 8.

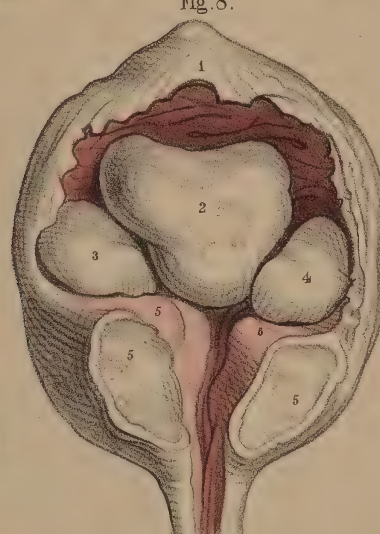


Fig. 9.

Fig. 10.

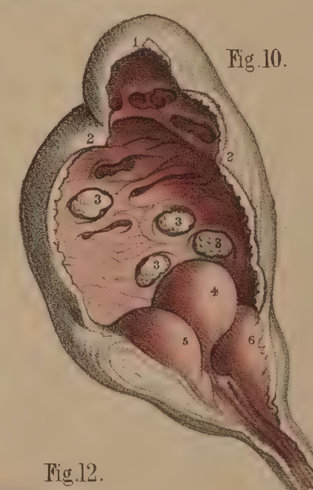


Fig. 11.

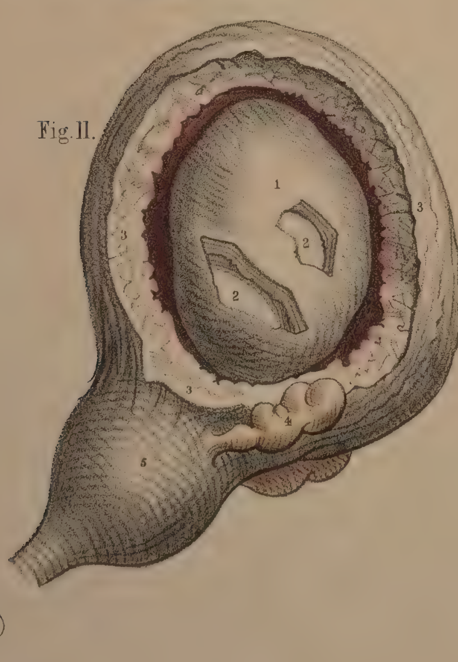
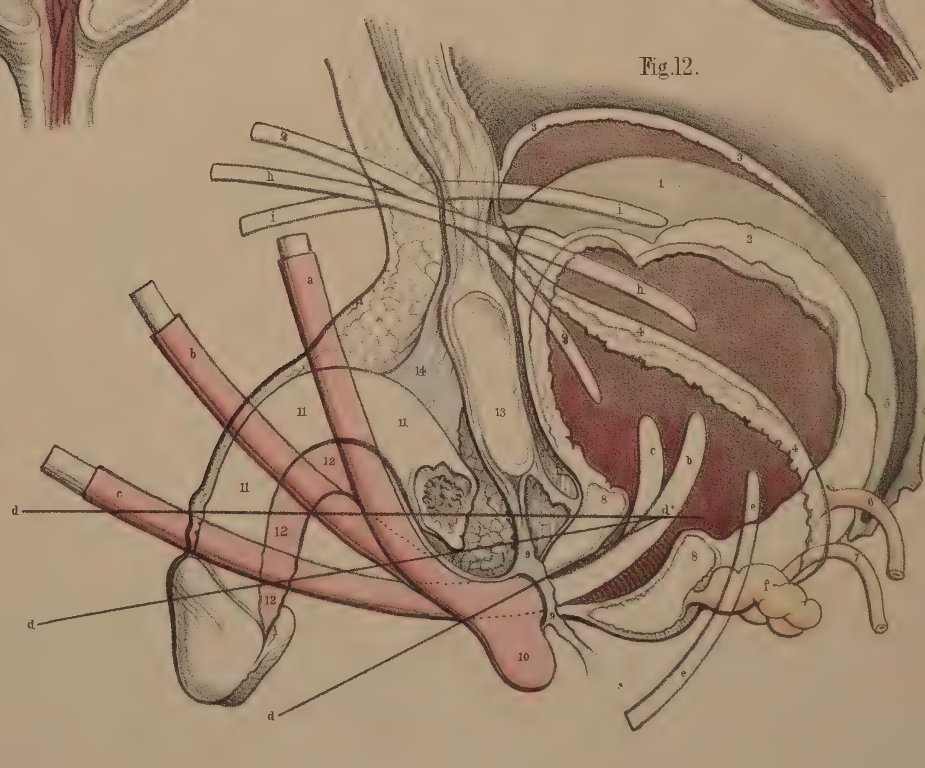


Fig. 12.



M & N. Hanhart, Imp^t.

COMMENTARY ON PLATE XLVII.

DEFORMITIES OF THE URINARY BLADDER.—THE OPERATIONS OF SOUNDING FOR STONE, OF CATHETERISM, AND OF PUNCTURING THE BLADDER.

The urinary bladder presents two kinds of deformity—viz., congenital and pathological. As examples of the former, may be mentioned, that in which the organ is deficient in front, and has become everted and protruded like a fungous mass through an opening at the median line of the hypogastrium; that in which the rectum terminates in the bladder posteriorly; and that in which the fœtal urachus remains pervious as an uniform canal, or assumes a sacculated shape between the summit of the bladder and the umbilicus. The pathological deformities are, those in which vesical fistulæ, opening either above the pubes, at the perinæum, or into the rectum, have followed abscesses or the operation of puncturing the bladder in these situations; and those in which the walls of the organ appear thickened and contracted, or thinned and expanded, or sacculated externally, or ridged internally, in consequence of its having been subjected to abdominal pressure while over-distended with its contents, and while incapable of voiding these from some permanent obstruction in the urethral canal. The bladder is liable to become sacculated from two causes—from a hernial protrusion of its mucous membrane through the separated fasciculi of its fibrous coat, or from the cyst of an abscess which has formed a communication with the bladder, and received the contents of this organ. Sacs, when produced in the former way, may be of any number, or size, or in any situation; when caused by an abscess, the sac is single, is generally formed in the prostate, or corresponds to the base of the bladder, and may attain to a size equalling, or even exceeding, that of the bladder itself. The sac, however formed, will be found lined by mucous membrane. The cyst of an abscess, when become a recipient for the urine, assumes after a time a lining membrane similar to that of the bladder. If the sac be situated at the summit or back of the bladder, it will be found invested by peritonæum; but, whatever be its size, structure, or position, it may be always distinguished from the bladder by being devoid of the fibrous tunic, and by having but an indirect relation to the vesical orifice.

Figure 1.—The lateral lobes of the prostate, 3, 4, are enlarged, and contract the prostatic canal. Behind them the third lobe of smaller size is divided into two parts, 6, 6, occupies the vesical orifice, and completes the obstruction. The walls of the bladder have hence become fasciculated and sacculated. One sac, 1, projects from the summit of the bladder; another, 2, containing a stone, projects laterally. When a stone occupies a sac, it does not give rise to the usual constitutional symptoms as indicating its presence, nor can it be always detected by the sound. But should the stone be of such a size and form as to project its point into the interior of the bladder from out the sac, and that the point of the instrument alights grating upon it, the case might be mistaken for a stone free in the bladder; when, if lithotomy were undertaken, the consequent failure of that operation may be readily inferred.

Figure 2.—The prostate, 10, 11, is greatly enlarged, and forms a narrow ring around the vesical orifice. Through this ring an instrument, 12, enters the bladder. The walls of the bladder are thickened and sacculated. On its left side appear numerous sacs, 2, 3, 4, 5, 6, 7, 8; and on the inner surface of its right side appear the orifices of as many more. On its summit another sac is formed. The ureters, 9, are dilated. The symmetrical sacculation in this case illustrates what is to be noticed of fig. 5; but here the large number of sacs is owing to the resisting fasciculi of the fibrous coat of the bladder multiplying the places where the yielding mucous coat could protrude between them, and become invested by the serous.

Figure 3.—Four calculi are contained in the bladder. This organ, thickened and fasciculated, is divided by two septa, 2, 4, into three compartments, each of which, 1, 3, 5, gives lodgment to a calculus; and another, 6, of these bodies lies impacted in the prostatic canal, and becomes a complete bar to the passage of a catheter, unless by being forced backwards by that instrument, which the septa would not readily permit. Supposing lithotomy to be performed in an instance of this kind, it is probable that, after the extraction of the calculi, 6, 5, the two upper ones, 3, 1, would, owing to their being embedded in the walls of the bladder, escape the forceps; or should the point of that instrument happen to touch them, and a trial be made by it to extract them, both the septa must inevitably be torn and the lining mucous membrane stripped from the bladder.

Figure 4.—The base of the bladder appears dilated into a large uniform sac, and separated from the upper part of the organ by a circular horizontal fold, 2, 2. The ureters, 3, 3, are also dilated. The left ureter, 3, 4, opens into the sac below this fold, while the right ureter opens above it into the bladder. In all cases of retention of urine from permanent obstruction of the urethra, the ureters are generally found more or less dilated. Two circumstances combine to this effect: while the renal secretion continues to pass into the ureters from above, the contents of the bladder under abdominal pressure are forced regurgitating into them from below, through their orifices. But the distended intestine-form of the ureters would appear to be generally owing to this simple physical cause: while the bladder is, from obstruction, habitually full of the urine, and cannot contain more, the ureters, continually receiving that fluid from the kidneys, must themselves become the retentive recipients of it, and increase their capacity accordingly.

Figure 5.—The bladder appears symmetrically sacculated. One sac, 1, is formed at its summit; others, 3, 2, project laterally; and two more, 5, 4, from its base. The ureters, 6, 6, are dilated, and enter the bladder between the lateral and inferior sacs. The bladder in this condition of symmetry is a good illustration of the uniform equable force of abdominal compression; but an uniform structural state of the organ is also necessary to effect it, so that one part does not more strongly resist compression (the bladder being distended) than another.

Figure 6.—Two sacs appear projecting on either side of, 4, the base of the bladder. The right one, 5, contains a calculus, 7; the left one, 6, of larger dimensions, is empty. The rectum lay in contact with the base of the bladder between the two sacs. The prostate is enlarged and its canal obstructed. In this instance of sacculated bladder that organ did not appear abnormally fibrous, proving that by no action of its own to overcome the retention of urine, but by abdominal superincumbent pressure, the sacs were produced; and proving, therefore, that the action of the bladder in voiding its contents is almost *nil,* and mainly owing to abdominal force.

Figure 7.—Two sacculi, 5, 6, appear projecting at the middle line of the base of the bladder, between the vasa deferentia, 4, 4, and behind 1, 2, the prostate, in the situation where the operation of puncturing the bladder *per anum* is recommended to be performed in retention of urine. These sacs, in a distended state of the bladder from urethral obstruction—they themselves being also tense and distended—could not be distinguished by examination *per anum* from an enlarged prostate. In each sac was contained a mass of phosphatic calculus. This substance is said to be secreted by the mucous lining of the bladder, while in a state of chronic inflammation; but there seems nevertheless very good reason for us to believe that it is, like all other calculous matter, a deposit from the urine.

Figure 8.—The prostatic canal is contracted by the lateral lobes, 5, 5; resting upon these, appear three calculi, 2, 3, 4, which nearly fill the bladder. This organ is thickened and fasciculated. In cases of this kind, and that last mentioned, the presence of stone is readily ascertainable by the sound.

Figure 9.—Two large polypi, and many smaller ones, appear growing from the mucous membrane of the prostatic urethra and vesical orifice, and obstructing these parts. In examining this case during life by the sound, the two larger growths, 2, 3, were mistaken by the surgeon for calculi. Such a mistake might well be excused if they happened to be encrusted with lithic matter, in which state, if lithotomy were had recourse to, their extraction by that operation would, owing to their pedicellate form, be readily effected. But not being in that condition, it might seem impossible for their true nature to be known, or that they were of any other kind than an enlargement of the third prostatic lobe.

Figure 10.—The three prostatic lobes, 4, 5, 6, are enlarged, and appear contracting the vesical orifice. In the walls of the bladder are embedded several small calculi, 3, 3, 3, 3, which, on being struck with the convex side of a sound, might give the impression as though a single

stone of large size existed. In performing lithotomy, these calculi would not be within reach of the forceps.

Figure 11.—The prostate is enlarged, its canal is narrowed, and the bladder is thickened and contracted. A calculus, 1, 2, appears occupying nearly the whole vesical interior. The incision in the neck of the bladder in lithotomy must necessarily be extensive, to admit of the extraction of a stone of this size, for in truth it does not appear (as stated by the advocates for sparing incision of the prostatic) that that part is more distensible than lacerable, and very probably in all cases of lithotomy they are only substituting laceration for incision,—the former being the worse mode of the two.

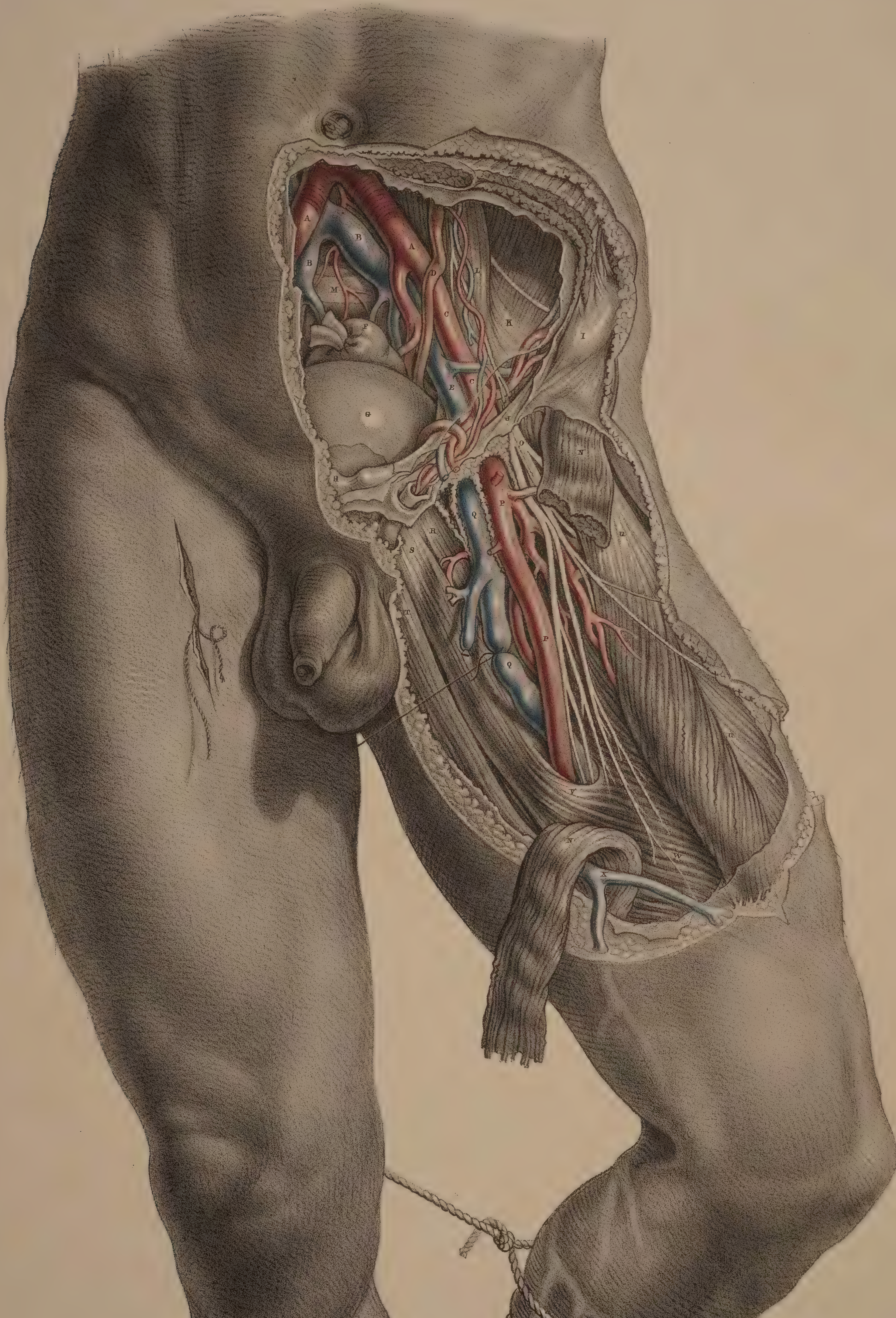
Figure 12 represents, in section, the relative position of the parts concerned in catheterism; the form and dimensions of the bladder in its collapsed, semi-distended, and inordinately distended states; and the operation of puncturing the organ in the latter condition above the pubes, or through the rectum. In performing catheterism, the patient is to be laid supine; his loins are to be supported on a pillow; and his thighs are to be flexed and drawn apart from each other. By this means the perinæum is brought fully into view, and its structures are made to assume a fixed relative position. The operator, standing on the patient's left side, is then to raise the penis so as to render the urethra, 12, as straight as possible between the meatus and the bulb. The urethra then assumes the form and position of *a*, 10. The instrument (the concavity of its curve being turned to the left groin) is now to be inserted into the meatus, and while being gently impelled through the canal, the urethra is to be drawn forwards, by the left hand, over the instrument. By thus stretching the urethra, its sides are rendered sufficiently tense for facilitating the passage of the instrument, and the orifices of the lacunæ become closed. While the instrument is being passed along this part of the canal, its point should be directed fairly towards the urethral opening, 9, of the triangular ligament, which is situated an inch or so below the pubic symphysis, 13. With this object in view, we should avoid depressing its handle as yet, lest its point be prematurely tilted up, and rupture the upper side of the urethra anterior to the ligament. As soon as the instrument has arrived at the bulb, 10, its further progress is liable to be arrested, from three causes:—1st, This portion of the canal is the lowest part of its perinæal curve, *a*, 10, 8, and is closely embraced by the middle fibres of the accelerator urinæ muscle, which, always becoming spasmodically contracted on the unaccustomed introduction of a foreign body, completely obstructs the urethra, by compressing the bulb like a pad against it. This compression, it appears to me, gives the anatomical signification and the physiological use of the bulb. Its presence allows grasp to the accelerator, and renders that muscle effective in suchwise as its name implies. The urethra is as the cylinder of a syringe, the bulb is its piston, and the muscle is the impelling force to accelerate the expulsion of the urethral contents which remain there when other forces which convey those contents thither are expended. The bulb, therefore, in the grasp of the accelerator, and compressing the urethral canal, may be regarded as a cause of natural stricture, always, while the point of a catheter touches the part; and the instrument, if rudely encountering such constriction, is liable to make a false passage, even though no abnormal organic stricture exist. 2nd, It is immediately succeeded by the commencement of the membranous urethra, which, while being naturally narrower than other parts of the canal, is also (as is said) the more usual seat of organic stricture, and is subject moreover to spasmodic constriction by the fibres of the "compressor urethræ" between the layers of the triangular ligament. 3rd, The triangular ligament is behind it, and if the urethral opening of the ligament be not directly entered by the instrument, this will bend the urethra against the front of that dense structure. On ascertaining these to be the causes of resistance, the instrument is to be withdrawn a little in the canal, so as to induce the relaxation of the muscles, and to admit of its being re-adjusted for engaging precisely the opening in the triangular ligament. As this structure is attached to the membranous urethra which perforates it, both these parts may be rendered tense, by drawing the penis forwards, and thereby the instrument may be guided towards and through the aperture. The instrument having passed the ligament, regard is now to be paid to the direction of the prostatic portion of the canal, 9, 8, which is upwards and backwards to the vesical orifice, 8, *d**, 8. In order that the point of the instrument may freely traverse the urethra in this direction, its handle, *a*, requires to be depressed, *b*, slowly towards the perinæum, and at the same time to be impelled steadily back in the line *d*, *d**, through the middle of the pubic arch, with which the prostatic urethra corresponds. If the third lobe of the prostate happens to be enlarged, the vesical orifice will accordingly be more elevated than usual. In this case, it becomes necessary to depress the instrument to a greater extent, *c*, than is otherwise required, so that its point, *c*, may surmount the obstacle. But since the suspensory ligament, 14, of the penis, 11, and the perinæal structures prevent the handle of the catheter being depressed beyond a certain degree, which is insufficient for the object to be attained, the instrument should possess the *prostatic curve*, *c*, *c*, compared with *c*, *b*. There can be no doubt that a moderately and uniformly curved instrument is (judging from the form of the urethra) that which is best suited for easy introduction into and through the canal. As little doubt can there be that a straight inflexible instrument, *d*, *d**, is one which is wholly inadapted for the operation, whether the parts be in their normal or abnormal state. But an instrument with too abrupt a curve is not less difficult of passage than a straight one, for while the latter in passage is never according to the natural axis of the whole canal, the former becomes too soon in that direction, and in its progress through the urethra obstructs itself by bending the part prematurely.

In the event of its being impossible to pass a catheter by the urethra, in cases of retention of urine threatening rupture, the base or the summit of the bladder, according as either part may be reached with the greater safety to the peritonæal sac, will require to be punctured. If the prostate be greatly and irregularly enlarged, it will be safer to puncture the bladder above the pubes, and here the position of the organ in regard to the peritonæum becomes the chief consideration. The shape of the bladder varies very considerably from its state of collapse, 4, 4, to those of mediate, 1, 2, 5, and extreme distension, 3, 3, 5. This change of form is chiefly effected by the expansive elevation of its upper half, which is invested by the peritonæum. As the summit of the bladder falls below, and rises above the level of the upper margin of the pubic symphysis, it carries the peritonæum with it in either direction. While the bladder is fully expanded there occurs an interval between the margin of the symphysis pubis and the point of reflexion of the peritonæum, from the recti muscles to the summit of the viscus. At this interval, close to the pubes, and in the median line, the trocar may be safely passed through the front wall of the bladder. The instrument, *h*, *h*, should, in all cases, be directed close over the upper border of the pubic symphysis, downwards and backwards, in a line pointing to the hollow of the sacrum, so as to insure its passage into the bladder with safety to the serous membrane. The instrument, *g*, *g*, points to the interior of the organ, even while partially filled. The instrument, *i*, *i*, though directed horizontally backwards, enters the summit of the bladder in its state of inordinate distension. For puncturing the fundus of the bladder the instrument, *e*, *e*, (when the position and size of the prostate have been ascertained) should be passed through the forepart of the lower end of the bowel into the bladder, at about half an inch behind the base of the prostate, and exactly in the median line. Here it would pass free of and between the seminal ducts, *f*, 7, converging to the prostate before, and would also be free of the end of the recto-vesical serous pouch, 5, 5, 6, behind. Puncturing the bladder is, however, at present, an operation which improved catheterism almost supersedes.

Note.—On considering the cases of physical impediments to the passage of urine from the vesical reservoir through the urethral conduit, it seems to me as if these were sufficient to account for the formation of stone in the bladder, or any other part of the urinary apparatus, without the necessity of ascribing it to a constitutional disease, such as that named the *lithic diathesis* by the humoral pathologists.

The urinary apparatus (consisting of the kidneys, ureters, bladder, and urethra) is known to be the principal emunctory for eliminating and voiding the detritus formed by the continual decay of the parts comprising the animal economy. The urine is this detritus in a state of solution. The components of urine are chemically similar to those of calculi, and as the components of the one vary according to the disintegration occurring at the time in the vital alembic, so do those of the other. While, therefore, a calculus is only as urine precipitated and solidified, and this fluid only as calculous matter suspended in a menstruum, it must appear that the lithic diathesis is as natural and universal as structural disintegration is constant and general in operation. As every individual, therefore, may be said to void day by day a dissolved calculus, it must follow that its form of precipitation within some part of the urinary apparatus alone constitutes the disease, since in this form it cannot be passed. On viewing the subject in this light, the question that springs directly is (while the lithic diathesis is common to individuals of all ages and both sexes), why the lithic sediment should present in the form of concrement in some and not in others? The principal, if not the sole, cause of this seems to me to be obstruction to the free egress of the urine along the natural passage. Aged individuals of the male sex, in whom the prostate is prone to enlargement, and the urethra to organic stricture, are hence more subject to the formation of stone in the bladder, than youths, in whom these causes of obstruction are less frequent, or than females of any age, in whom the prostate is absent, and the urethra simple, short, readily dilatable, and seldom or never strictured. When an obstruction exists, lithic concretions take place in the urinary apparatus in the same manner as sedimentary particles cohere or crystallize elsewhere. The urine becoming pent up and stagnant while charged with saline matter, either deposits this around a nucleus introduced into it, or as a surplus when the menstruum is insufficient to suspend it. The most depending part of the bladder is that where lithic concretions take place; and if a sacculus exist here, or anywhere so as to become a recipient for the matter, this circumstance will favour the formation of stone.

PL. XLVIII.



M. & N. Hanhart, Imp.t

COMMENTARY ON PLATE XLVIII.

THE SURGICAL DISSECTION OF THE ILIAC AND FEMORAL REGIONS. DELIGATION OF THE EXTERNAL ILIAC AND FEMORAL ARTERIES.

Through the middle of the groin, over the outer third of the horizontal ramus of the pubic bone, and comparatively superficial, the principal bloodvessels and nerves are transmitted to the corresponding limb. The main artery of the lower limb, extending from its aortic origin throughout, frequently becomes the subject of a surgical operation, in respect to its several portions, each of which is usually described as limited, according to the extent of the region which it traverses. But, as in examining any one of those parts irrespective of the others, many facts of chief surgical importance are thereby obscured and overlooked, I propose to consider the vessel *as a whole*, continuous from the aorta to where it appears in the popliteal space. The general course and position of the main artery may be described as follows:—

The abdominal aorta usually bifurcates on the body of the fourth lumbar vertebra. The level of the aortic bifurcation corresponds with the situation of the navel in front, and the crista ilii laterally. The aorta is in this situation borne so far forwards by the lumbar spine as to occupy an almost central position in the cavity of the abdomen, and in the erect and supine posture is very nearly on the same plane with the symphysis pubis. If the abdomen were pierced in two lines, one extending from a little to the left side of the navel, horizontally backwards to the fourth lumbar vertebra, and the other from immediately over the middle of one crista ilii, transversely to a corresponding point in the opposite side, these lines would intersect at the aortic bifurcation. The two arteries, A, A, into which the aorta divides symmetrically at the median line, diverge from one another in their descent towards the middles of the two groins, and each appears to pass almost straight to the popliteal space. As both vessels correspond in form and relative position, the description of one will serve for the other.

While the thigh is abducted and rotated outwards, if a line be drawn from the navel to a point of the inguinal fold, midway between I, the anterior iliac spine, and H, the symphysis pubis, and continued thence to the inner condyle of the femur, it would indicate the general course of the artery, A C P. In this course, the vessel may be regarded as a main trunk, giving off at intervals large branches for the supply of the pelvic organs, the abdominal parietes, and the thigh. Its accompanying vein, B E Q, lying for the most part close to its inner side, has the same direction as it, and exhibits corresponding branches. From the point where the artery leaves the aorta, down to the inguinal fold, J, it is within the abdomen, and here, therefore, all operations affecting the vessel are attended with more difficulty and danger than elsewhere in its course.

The artery of the lower limb, arising at the bifurcation of the aorta on the fourth lumbar vertebra, descends obliquely outwards to the sacro-iliac junction, and here it gives off from its inner side its first branch (internal iliac) to the pelvic organs. The main vessel is named *common iliac*, at the interval between its origin from the aorta and the point A, where it gives off the internal iliac branch. This interval is very variable as to its length, depending either upon a high division of the artery itself or a low division of the aorta, or upon both circumstances, in which latter case it is extremely short—but it is stated to be usually two inches. The artery, C, continuing to diverge in its first direction from its fellow of the opposite side, descends along the margin of the true pelvis as far as Poupart's ligament, J, over the os pubis, and here it gives off, from opposite sides, its next principal branches,—viz., the epigastric and circumflex iliac. At the interval between the internal iliac and those branches, the main artery, C, is named *external iliac;* and the surgical length of this part is also liable to vary, in consequence of a high division of the common iliac or of the epigastric or circumflex iliac branches arising from it higher up or lower down than usual. The main artery, after passing beneath the middle of Poupart's ligament, next gives off the profundus branch, P, to supply the thigh, of which it is the proper and chief nutrient vessel; the other branches of the common trunk being here few and of small size. This branch generally arises at a point an inch and half or two inches below the fold of the groin, marked by Poupart's ligament; and between it and the ligament above, the main artery is named *common femoral;* but, practically considered, it will appear that this portion of the vessel is to be measured not by the ligament but by the situations of the origins of the branches (circumflex iliac and epigastric), which, when arising high above that structure, shorten the clear length of the external iliac, and extend that of the common femoral, and when arising below the part (which they often do) have a converse effect in regard to those portions. Moreover, those branches, when given off from the main artery immediately above the ligament, and the profundus close to its lower border, leave scarcely an interval to which to apply the name common femoral, and none at all when they arise together. From the point where the profundus branch arises, down to the popliteal space, the vessel, P P, remains as an undivided trunk, being destined to supply the leg and foot, and is the *femoral* artery only in regard to situation. In this course, the artery is accompanied by the vein, B E Q, which, according to the region in which it lies, assumes different names, corresponding to those applied to the artery. Both vessels may now be viewed in relation to each other, and to the several structures which are in connexion with them.

The two vessels above Poupart's ligament are behind the intestines, and closely invested by the serous membrane. In the right iliac region they are immediately overlaid by the ileo-cœcal part of the bowel; in the left side the sigmoid flexure of the colon rests upon them. The origin of the vena cava is close to the right side of the bifurcation of the aorta; and here both vessels are supported by the lumbar spine. Each of the two arteries into which the aorta divides has its accompanying vein on its inner side, but the common iliac part of the right artery, A, is seen to pass over the upper ends of both the veins, as these joining beneath it form the commencement of the vena cava. The external iliac part of each artery has its vein on its inner side. At the point where the artery gives off its internal iliac branch, the ureter, D, crosses it, and thence descends to the bladder, while that branch itself crosses the upper end of the external iliac vein in the same direction. The internal iliac branch subdivides in general so soon after its origin, is so deeply seated, is so complicated by the veins accompanying its several branches and congregating to join the external iliac vein at its root, and is at the same time in such close connexion with important organs, as to make no call for surgical description.

The external iliac vessels, in approaching Poupart's ligament along the border of the true pelvis, apply themselves to the inner side of the psoas muscle, and are invested and bound to their place by the peritonæum, and a thin process of the iliac fascia. Some lymphatic bodies are here found to lie in the course of the vessels; forming a chain, continuous with those of the thigh, through the femoral canal, and are known, like those in the axilla, to cause vascular obstruction when they have become morbidly enlarged. The spermatic artery and vein, together with the genito-crural nerve, descend upon the psoas muscle along the outer border of the iliac artery. When arrived at Poupart's ligament, the iliac vessels, E C, become much complicated by their own branches, and also by the spermatic vessels and duct, as these are about to pass from the abdomen through the internal inguinal ring. While passing beneath the middle of Poupart's ligament, the iliac artery, having its vein close to its inner side, rests upon the inner border of the psoas muscle, and in this place it may be effectually compressed against the os pubis. While within the abdomen no nerve of any surgical importance is in apposition with the vessels. The anterior crural nerve, O, which in the iliac region is concealed between the psoas and iliacus muscles, and separated by the former from the vessels, now comes into view, situated on the outer side of the artery. When the vessels, P, Q, have passed from beneath Poupart's ligament, the serous membrane no longer covers them, but the fibrous membrane is seen to invest them in the form of a sheath, divided, as already described, into three compartments, of which the middle one receives the vein; the outer one the artery; and the inner one, which is named the femoral canal, is usually

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FIGURE OF PLATE XLVIII.

A A, Right and left common iliac arteries.—B B, Right and left common iliac veins.—C, External iliac artery.—D, Ureter.—E, External iliac vein.—F, Rectum intestinum.—G, Urinary bladder.—H, Symphysis pubis.—I, Anterior superior iliac spinous process.—J, Poupart's ligament.—K, Peritonæum investing the psoas and iliacus muscles.—L, Psoas muscle supporting the spermatic vessels.—M, Intervertebral substance between the fourth and fifth lumbar vertebræ.—N N, Sartorius muscle divided.—O, Anterior crural nerve.—P P, Femoral artery.—Q Q, Femoral vein.—R, Pectinæus muscle.—S, Adductor longus muscle.—T, Gracilis muscle.—U U, Rectus femoris muscle.—V, Tendinous expansion of adductor longus muscle, joining the vastus internus muscle, and covering the femoral vessels.—W, Vastus internus muscle.—X, Part of saphena vein.

occupied by a lymphatic body, and is that which occasionally gives egress to a hernia.

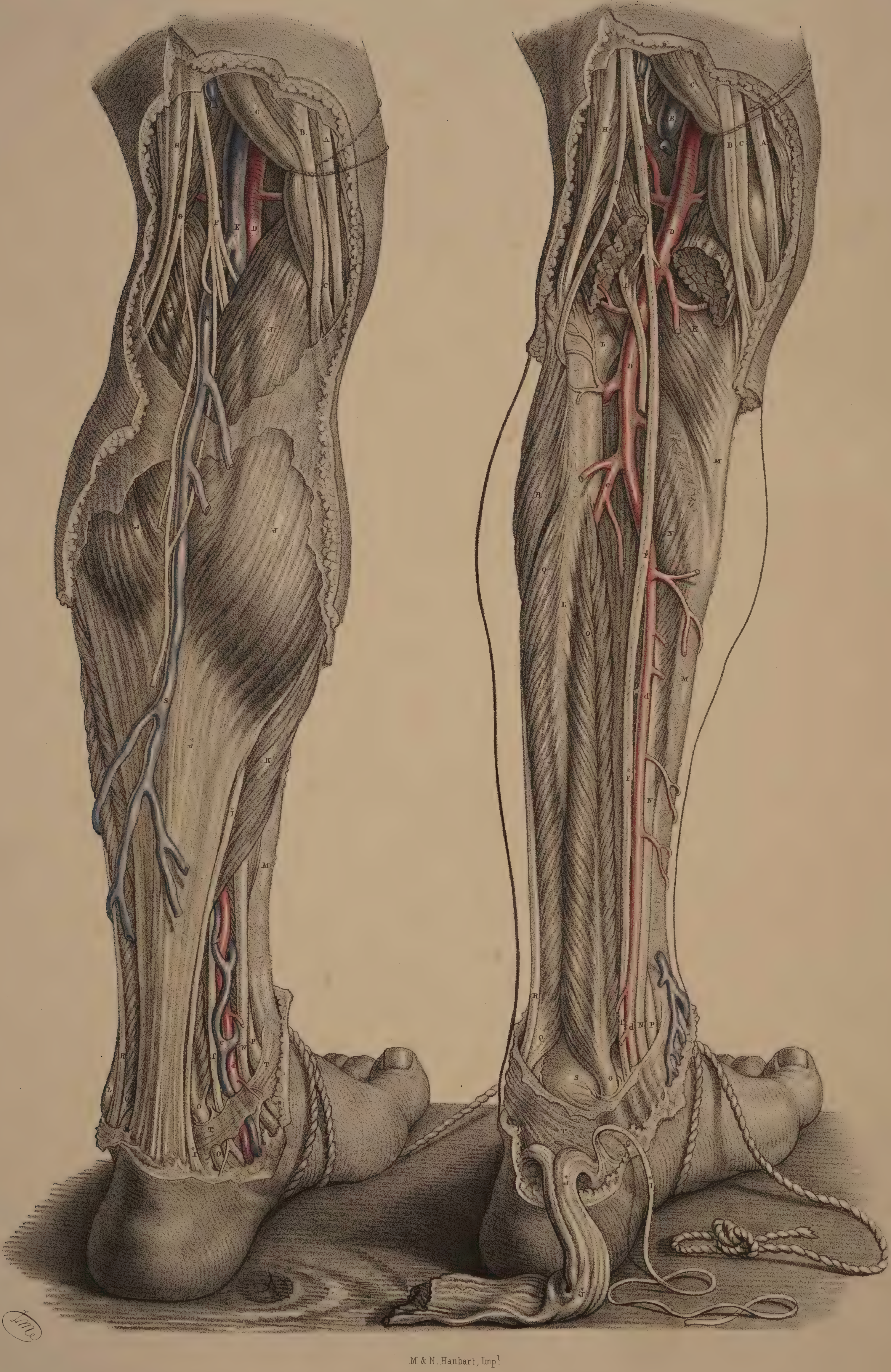
The femoral vessels in the upper third of the thigh traverse a triangular space, the base of which is formed by Poupart's ligament, whilst the sides and apex are represented by the sartorius and adductor longus muscles, approaching each other at the junction of the upper with the middle third of the thigh. In the undissected state of the part, the structures which bound this space can in general be easily recognised. A central depression, in lean subjects, extends from the middle of its base to its apex, and marks the course of the vessels. Near the middle of Poupart's ligament, the vessels are comparatively superficial, being supported forwards by the os pubis,—and here the artery may be felt pulsating; but lower down, as they approach the apex of the triangle, the vessels gradually become deeper, till the sartorius muscle inclining from its origin obliquely inwards to the centre of the thigh, at length overlaps them. The inner border of the sartorius muscle at the lower part of the upper third of the thigh, guides to the position of the artery. Whilst traversing the femoral triangle, the vessels enclosed in their proper sheath are covered by the fascia lata, adipose membrane, and integument. In this place they lie imbedded in much loose cellular and adipose tissue. The femoral vein is on the same plane with the artery near Poupart's ligament; but from this place downwards through the thigh, the vein gradually winds from the inner side to the back of the artery; and when both vessels, supported by the adductor muscles, pass under cover of the sartorius, they enter a strong fibrous sheath, V, which appears derived from the adductor longus tendon, and stretching over them becomes firmly attached to the contiguous origin of the vastus internus muscle. The artery in this sheath approaches the shaft of the femur near its middle; and in this place it may be readily compressed against the bone by the hand. The anterior crural nerve, O, dividing into several muscular branches immediately below Poupart's ligament on the outer side of the artery, sends one or two of them down over the femoral sheath; and one of these—the long saphenus nerve—enters the sheath and follows the artery as far as the opening in the great adductor tendon, through which that vessel passes to the popliteal space. The nerve at the opening leaves the artery and descends subcutaneously on the inner side of the knee, leg, and foot. The femoral artery, before it passes through this opening into the popliteal space, gives off its anastomotic branch, to ramify about the knee. The profundus branch springs from the outer side of the femoral artery, usually at a distance of from one to two inches (seldom more) below Poupart's ligament, and soon subdivides for the supply of the various muscles on the front and back of the thigh. The femoral artery in a few instances has been found double, but, unlike the duplex state of the brachial artery, the branches of which become the radial and ulnar, those of the femoral artery re-unite into a single trunk in all those instances (as far as I know) which have been seen, previously to entering the popliteal space.

The main artery of the lower limb may be exposed and tied in any part of its course from the aorta to the popliteal space. But the situation most eligible for performing such an operation depends of course upon circumstances both anatomical and pathological. If an aneurism affect the popliteal part of the vessel, or if, from whatever cause arising, it be found expedient to tie the femoral above this part, the place (as described by Scarpa) best suited for the operation is that where the artery first passes under cover of the sartorius muscle. For, considering that the vessel gives off no important branch (except the anastomotic and articular, to ramify about the knee joint) destined to supply any part of the thigh or leg between the profundus branch and those into which it divides below the popliteal space, the arrest to direct circulation will be the same in amount at whichever part of the vessel between these two points the ligature be applied. But since the vessel in the situation specified can be reached with greater facility here than elsewhere lower down (where Hunter tied it); and since, moreover, a ligature applied to it here will be sufficiently removed from the profundus branch above, and the seat of disease below, to produce the desired result, the choice of the operator is determined accordingly. The steps of the operation performed at the upper third of the thigh, where the artery is about to pass beneath the sartorius, are these: an incision of sufficient length—from two to three inches—is to be made over the course of the vessel, so as to divide the skin and adipose membrane, and expose the fascia lata, through which, being thin and transparent, the inner edge of the sartorius muscle becomes readily discernible. A vein (anterior saphena) may be found to cross in this situation, but the internal saphena vein proper is not met with, as this vessel lies nearer the inner side of the thigh. The fascia having been next divided, the inner edge of the sartorius is to be turned aside, and now the pulsation of the artery in its sheath will indicate its exact position. The sheath (that which is prolonged upon the vessel as a production of the transversalis fascia, and which here closely invests it) is next to be opened, for an extent sufficient only to carry the point of the ligature-needle safely around the artery, care being taken not to injure the femoral vein, which is close behind it, and also to exclude any nerve which may be in contact with the vessel. When the ligature has been applied, the aneurism is to be examined to know if its pulsation be completely arrested. If such be the case, the singleness of the femoral artery will be proved; but if the aneurismal motion still continue, then the duplex state of the vessel may be safely inferred, and measures adopted accordingly. A double femoral artery is however so rare an occurrence (though, singularly enough, the first subject I ever dissected exhibited this very condition), as to require no further comment.

If an aneurism affect the common femoral portion of the artery, the external iliac part would require to be tied, because, between the seat of the tumour, however small this be, and the epigastric and circumflex iliac branches above, there would not be a sufficient interval of the main vessel to allow the ligature to rest "undisturbed;" and even if the aneurism arose from the femoral below the profundus branch in the upper third of the thigh, or if, after amputation of the thigh, a secondary hæmorrhage took place from the femoral and the branches of the profunda artery, a ligature would with more safety be applied to the external iliac part than to the common femoral; because of this latter, even when of its clear normal length, presenting so small an interval between the epigastric and profundus branches. In addition to this, it must be noticed, that occasionally the profundus itself, or some one of its branches, (external and internal circumflex, &c.,) arises as high up as Poupart's ligament, close to the origin of the epigastric and circumflex iliac. But though mention is here made thus admonitorily respecting the application of a ligature to the main artery close below the origin of some of its principal branches, as a cause of failure in the operation, I must confess, for my own part, that I rather follow precedent and custom than subscribe to the doctrine. For, judging of the matter on pure physical principle, which is implied when making use of the term "disturbance" of a ligature owing to its having the position above mentioned, I think that when we see the whole force of the arterial current impelled point blank against the tied end of the vessel, and continuing to be so until the period of complete organic closure and obliteration of its channel; if that force be not sufficient cause to disturb the ligature, how can the proximity of this to the distal side of the root of a large collateral branch be so? Nay, does it not stand for reason that it would rather be a preventive to the occurrence by *diverting* the direct current, and, in the exact ratio of the size of such branch, diminish that force which otherwise would take full effect at the seat of the ligature wherever this happen to be applied. Be this as it may, however, the remark will not be wholly devoid of value if it lead to a consideration of prime importance—viz., that in placing the ligature whenever practicable on the main artery *below* a large branch, we add very materially to the chances of maintaining the vitality of the member through the medium of the collateral circulation.

The external iliac part of the artery, when requiring to be tied, may be reached in the following way: an incision, commencing at the anterior superior iliac spinous process, is to be carried inwards parallel to, and above, Poupart's ligament, as far as the outer margin of the internal abdominal ring. This incision is the one best calculated for avoiding the epigastric artery, and for not disturbing the peritonæum more than is necessary. The skin and the three abdominal muscles having been successively incised, the fibrous transversalis fascia is next to be carefully divided, so as to expose the peritonæum. This membrane is then to be gently raised by the fingers, from off the adjacent parts of the iliacus and psoas muscles, as far inwards as the margin of the true pelvis where the artery lies. On raising the peritonæum the spermatic vessels will be found adhering to it. The iliac artery itself is liable to be displaced by adhering to the serous membrane, when this is being detached from the inner side of the psoas muscle. The artery having been divested of its serous covering as far up as a point midway between the epigastric and internal iliac branches, the ligature is to be passed around it in this place, where it will be safely removed from the seat of the disease. As the vein lies close along the inner side of the artery, the point of the instrument should first be inserted between them, and passed from within outwards, in order to avoid wounding the vein. If an aneurism affect the upper end of the external iliac artery, it is proposed to tie the common iliac; but this is an operation of so serious a nature, that it can in this respect be exceeded only by tying the aorta itself.

Fig. 1. Fig. 2. PL. XLIX.



M & N. Hanhart, Imp.

COMMENTARY ON PLATES XLIX. L. & LI.

THE SURGICAL DISSECTION OF THE POPLITEAL SPACE, THE LEG, THE ANKLE, AND THE FOOT. DELIGATION OF THE POPLITEAL, POSTERIOR TIBIAL, PERONÆAL, AND ANTERIOR TIBIAL ARTERIES. MECHANISM OF THE FOOT. ITS DEFORMITIES. AMPUTATION.

In the lower extremity, as in the upper one, we find, on dissection, an obvious conformity between the osseous and the arterial skeletons. The latter divides and subdivides into principal branches exactly according to the multiplication of the segmental parts of the former. The femoral artery is a single trunk passing sidelong with the femur, just as the brachial artery is single with the humerus; the femoral artery divides according to the bones of the leg just as the brachial artery divides according to the bones of the forearm; and the crural arteries subdivide according to the number of toes, in the same manner as the arteries of the forearm subdivide according to the number of the fingers. This correspondence between the osseous and arterial skeletons in both the upper and the lower members naturally leads to a comparison of both, and the result is a recognition of parallelism scarcely less marked than that which is self-evident as existing between the opposite limbs. In drawing this comparison between the upper and lower limbs we record their respective designs. Just as far as we can trace their similitude we may mark their dissimilitude to commence; but we shall discover that the latter condition is solely the effect of a modification of analogous elementary parts, and that upon the amount of that modification depends the capability of each to perform its particular motions and serve its special uses. And while in the comparison of both members as entireties we may thus appreciate the sum-total of their anatomical and functional sameness and difference, we may read it as plainly in the comparison of their smallest parts, which in the aggregate constitute the whole. Thus, if the likeness between a humerus and a femur, between the bones of the forearm and those of the leg, between a carpus and a tarsus, between a metacarpus and a metatarsus, between the fingers and the toes, at once strikes the attention of even the casual observer, we as anatomists have but to pursue the comparison, and discover that the small pisiform bone of the carpus is the analogue of the large os calcis, and that simply what the greater is to the lesser, the foot is to the hand—namely, a form of quantity, upon whose increase or degradation depends the functional difference which gives to the one the name of *prehensile organ*, and to the other that of an *organ of progression*. Premising these few remarks, we may pass to the examination of the anatomy of the lower extremity, expecting to find what we shall find—namely, a marked correspondence between it and the upper limb, not only in respect to its vascular and osseous portions, but for the most part also as to its muscles, whereupon it will appear that the several operations required to be performed on the one member are to be conducted in much the same manner, and on the same principle, on the other.

On comparing the bend of the knee with the bend of the elbow, as evident a correspondence can be discerned between these two regions as exists between the groin and the axilla.

In front of the knee appears, subcutaneously, the patella—a large sesamoid bone developed in the united tendons of the great extensor muscles on the forepart of the thigh. Between the integument and the patella a bursa exists, evidently for the same purpose here as that of the one over its analogue—the olecranon process of the ulna—for facilitating motion and obviating the effects of pressure. The bursa is, however, from excessive and habitual pressure, liable to become inflamed, and form a tumour by the accumulation of its secretion. By its posterior surface, which is articularly moveable on the intercondyloid anterior face of the femur, the patella constitutes a part of the knee-joint. Its sides give attachment to the two vasti muscles; its upper border to the rectus femoris and crureus muscles, and from its anterior surface the tendinous fibres of those muscles are continued under the name *ligamentum patellæ*, to be inserted into the tubercle on the forepart of the upper end of the tibia. The use of the patella is to give effect to the action of the muscles in extending the leg, and to give protection to the joint.

Behind the knee-joint, the muscles which connect the leg with the thigh bound the space named *popliteal*. When the integuments and subcutaneous adipose substance are removed from this place, the dense fascia lata may be seen binding these muscles so closely together as to leave but a very narrow interval between them at the mesial line. On removing this fascia and extending the joint, the muscles part asunder, and the popliteal space as usually described is thereby formed. This region now presents of a lozenge-shaped form, of which the widest diameter is opposite the knee-joint. The flexor muscles,—viz., the biceps, H, externally, and the semimembranosus, C, and semitendinosus, B, internally,—in diverging from each other as they pass down from the sides of the thigh to those of the upper part of the leg, form the upper angle of this space; and its lower angle is described by the two heads of the gastrocnemius muscle, J J, arising inside the flexors, from the condyles of the femur, and joining each other a little below the flexure of the joint. While those muscles bound the space laterally, the lower end and condyles of the femur and the upper end of the tibia, with the popliteus muscle and the posterior ligaments of the joint, bound it in front.

Like the extensor muscles, the flexors are very powerful, and necessarily so, for, being inserted into the bones of the leg close below the knee-joint, they act at a disadvantageous leverage, giving unbridled motion to the limb at the expense of power. The biceps muscle externally, arising by two heads—one from the tuber ischii, and the other from the inferior third of the posterior surface of the femur, between the origins of the vastus externus and the adductors,—ends in a strong, short tendon, which, passing behind the outer condyle, is inserted into the head of the fibula, and has connexions also with the fascia of the leg. Internally, on the back of the thigh, appear the semitendinosus and semimembranosus muscles, the former of which, the more superficial of the two, arises in common with the long head of the biceps from the tuber ischii, and, descending to a point three or four inches above the knee-joint, ends in a rounded tendon, which is inserted into the anterior surface of the tibia below the tubercle of that bone. The semimembranosus, arising also from the tuber ischii by a flattened tendon, and presenting thick and fleshy in the middle and lower parts of the thigh, ends, a little above the inner condyle of the femur, in a strong tendon, which divides into three parts, one of which becomes inserted into the posterior surface of the head of the tibia, another being directed upwards and outwards, strengthening the capsular ligament, and another part turning downwards, and forming a fascia over the popliteus muscle. Covering the tendons of the two last-named muscles appear those of the gracilis and sartorius, inserted into the internal surface of the head of the tibia. In connexion with the tendons of insertion of those several muscles, bursæ are to be met with, which not unfrequently become inflamed and distended, and simulate a popliteal aneurism as well by form as by having an impulse communicated to it from the popliteal artery. Bursæ are also situated between the condyles of the femur and the tendinous origins of the gastrocnemius. This muscle and the solæus may be regarded as one, as well from the fact of their having but a single tendon of insertion as from their action on the heel being the same. The gastrocnemius arising by two heads, each from over the back of the corresponding condyle of the femur, and the fleshy fibres of the two converging and uniting a little below the knee, and the solæus arising also by two heads,—one from the back of the upper third of the fibula, and the other from the middle of the tibia below the insertion of the popliteus muscle,—we find the two (gastrocnemius and solæus) united by a common tendon (tendo Achillis), which is inserted into the back of the os calcis, having, between it and that bone, a bursa to obviate friction. The plantaris muscle arising from the external condyle of the femur, under the external head of the gastrocnemius, ends, where it crosses the popliteal vessels, in a tendon which descends over the solæus to gain the inner side of the tendo Achillis, and, with this, is inserted into the os calcis. The popliteus muscle arising from the outer surface of the external condyle of the femur crosses, obliquely inwards and downwards, the back of the joint, for which it serves as an active ligament, having connexion with the capsule, and is inserted into the

FIGURES OF PLATE XLIX.

Figure 1.—A, Tendon of gracilis muscle.—B, Tendon of semitendinosus muscle.—C, Semimembranosus muscle.—D, Popliteal artery; d, posterior tibial artery.—E, Popliteal vein; e, venæ comites.—F f, Posterior tibial nerve.—G, Peronæal nerve.—H, Biceps muscle.—I*, Tendon of plantaris muscle.—J J, Gastrocnemius muscle.—J*, Tendo Achillis. K, Solæus muscle.—L, External malleolus.—M, The tibia.—N, Tendon of flexor communis digitorum muscle.—O, Tendon of flexor longus pollicis muscle.—P, Tendon of tibialis posticus muscle.—Q, Tendon of peronæus brevis muscle.—R, Tendon of peronæus longus muscle.—S, short saphena vein.—T T, Annular ligament.

Figure 2.—All parts except the following are lettered as in fig. 1.—K, Popliteus muscle.—L, Upper part of the fibula.—S, Astragalus.

posterior surface of the upper part of the tibia. The popliteal space is filled with adipose substance, in which are embedded several lymphatic bodies, and through which pass the principal vessels and nerves to the leg.

In the dissection of the popliteal space, the more important parts first met with are the branches of the great sciatic nerve. In the upper angle of this space, this nerve, immediately beneath the fascia and between the lateral muscles, will be found dividing into the peronæal, G, and posterior tibial branches, F. The peronæal nerve descends close to the inner margin of the tendon of the biceps muscle; and, having reached the outer side of the knee, Fig. 2, below the insertion of the tendon of that muscle into the head of the fibula, L, winds round the neck of this bone under cover of the peronæus longus muscle, R, to come into connexion with the anterior tibial artery. The posterior tibial nerve, F, Fig. 1, descends the popliteal space midway to the cleft between the heads of the gastrocnemius; and, after passing beneath this muscle, to gain the inner side of the popliteal artery, D, Fig. 2, it then passes beneath the solæus muscle also, and accompanies the posterior tibial artery. On the same plane with and close to the posterior tibial nerve in the popliteal space, will be seen the terminal branch of the lesser sciatic nerve, together with a small artery and vein destined for distribution to the skin and other superficial parts on the back of the knee. Opposite the heads of the gastrocnemius, the peronæal and posterior tibial nerves, separated from each other, give off each a branch, both of which descend along the mesial line of the calf, and joining near the upper end of the tendo Achillis, the single nerve here, Fig. 1, becomes superficial to the fascia, and thence descends behind the outer ankle to gain the external border of the foot, where it divides into cutaneous branches and others to be distributed to the three or four outer toes. In company with this nerve will be seen the posterior saphena vein, S, which, commencing at the outer border of the foot, passes behind the outer ankle, and ascends the mesial line of the calf to join the popliteal vein, in the cleft between the heads of the gastrocnemius.

On removing next the adipose substance and lymphatic glands from the popliteal space, we expose the popliteal vein, E, and artery, D, Fig. 1. The relative position of these vessels and the posterior tibial nerve may now be seen. Between the heads of the gastrocnemius the nerve, F, giving off large branches to this muscle, lies close upon the popliteal vein, where this vessel, becoming more superficial by the projection of the back of the knee-joint, is joined by the posterior saphena vein. Beneath and to the inner side of the veins the popliteal artery, D, appears. On tracing the vessels and nerve from this point upwards through the popliteal space, we find the nerve occupying a comparatively superficial position at the mesial line, while the vessels are directed upwards, forwards, and inwards, passing deeply, as they become covered by the inner flexor muscles, C B, to the inner side of the lower third of the femur, where they perforate the tendon of the adductor magnus muscle.

The popliteal artery, D, Fig. 2, being the continuation of the femoral, extends from the opening in the great adductor tendon at the junction of the middle and lower third of the thigh, to the point where it divides, in the upper and back part of the leg, at the lower border of the popliteus muscle, K, into the anterior and posterior tibial branches. In order to expose the vessel through this extent, we have to divide and reflect the heads of the gastrocnemius muscle, J J, and to retract the inner flexors. The popliteal artery will then be seen passing obliquely down the middle of the back of the joint. It is deeply placed in its whole course. Its upper and lower thirds are covered by large muscles; whilst the fascia and a quantity of adipose tissue overlies its middle. The upper part of the artery rests upon the femur, its middle part upon the posterior ligament of the joint, and its lower part upon the popliteus muscle. The popliteal vein, E, Fig. 1, adheres to the artery in its whole course, being situated on its outer side above, and posterior to it below. The vein is not unfrequently found to be double; one vein lying to either side of the artery, and both having branches of communication with each other, which cross behind the artery. In some instances the posterior saphena vein, instead of joining the popliteal vein, ascends superficially to terminate in some of the large veins of the thigh. Numerous lymphatic vessels accompany the superficial and deep veins into the popliteal space, where they join the lymphatic bodies, which here lie in the course of the artery.

The branches derived from the popliteal artery are the muscular and the articular. The former spring from the vessel opposite those parts of the several muscles which lie in contact with it; the latter are generally five in number—two superior, two inferior, and one median. The two superior articular branches arise from either side of the artery, and pass around the lower end of the femur, the one beneath the outer, the other beneath the inner flexors, above the knee-joint; and the two inferior pass off from it, the one internally, around the inner side of the head of the tibia, the other externally, under the external lateral ligament, both being beneath the heads of the gastrocnemius below the joint; while the middle articular enters the joint through the posterior ligament, to supply the adipose substance and the synovial membrane. The two superior and inferior articular branches anastomose freely around the knee behind, laterally, and in front, where they are joined by the terminal branches of the anastomotic, from the femoral, and by those of the recurrent, from the anterior tibial. The anastomotic branch is also articular: it arises from the femoral where this pierces the tendon of the adductor magnus muscle, and, passing down in front of that tendon, ramifies over the forepart of the knee beneath the vastus internus muscle which it supplies, and inosculates freely with the other articular branches. The main vessel, having arrived at the lower border of the popliteus muscle, where it is about to pass beneath the solæus, divides into two branches, of which one passes through the interosseous ligament to become the anterior tibial; while the other, after descending a short way behind the flexor communis, between the bones of the leg, separates into the peronæal and posterior tibial arteries. In some rare instances the popliteal artery is found to divide above the popliteus muscle into the anterior, or the posterior tibial, or the peronæal. The popliteal artery, unlike the vein, is never double.

The two large muscles (gastrocnemius and solæus), forming the calf of the leg, have to be removed, together with the deep fascia, in order to expose the posterior tibial, and peronæal vessels and nerves. Beneath those muscles the fascia forms a sheath for the vessels, and binds them close to the deep layer of muscles in their whole course down the back of the leg. The point at which the main artery, D, Fig. 2, gives off the anterior tibial, is generally at the lower border of the popliteus muscle, on a level with the neck of the fibula; that at which the artery again subdivides into the peronæal, E, and posterior tibial branches, D, is in the mesial line of the leg, and generally on a level with the junction of its upper and middle thirds. From this place the two arteries diverge in their descent, the peronæal being directed along the inner border of the fibula towards the back of the outer ankle; while the posterior tibial, approaching the inner side of the tibia, and having the flexor communis digitorum between it and the bone, courses towards the back of the inner ankle. The gastrocnemius and soleus muscles overlie both arteries in their upper two-thirds; but as these muscles taper towards the mesial line where they end in the tendo Achillis, J*, Fig. 1, they leave the posterior tibial artery, D, with its accompanying nerve, F, and vein, E, uncovered in the lower part of the leg, except by the skin and the superficial and deep layers of the fasciæ, the latter of which is of considerable density. The peronæal artery is deeply situated in its whole course. Soon after its origin it passes under cover of the flexor longus pollicis, O, a muscle of large size arising from the lower three-fourths of the fibula, and will be found overlapped by this muscle on the outer border of the tendo Achillis, as low down as the outer ankle. The two arteries are accompanied by venæ comites, which, with the short saphena vein, form the popliteal vein. The posterior tibial artery is closely followed by the posterior tibial nerve, F*, Fig. 2. In the popliteal space this nerve crosses to the inner side of the popliteal artery, where both are about to pass under the gastrocnemius muscle, to which they give large branches. Near the middle of the leg the nerve crosses to the outer side of the posterior tibial artery, and in this relative position both descend straight to a point about midway between the inner ankle and calcaneum, where they appear having the tendons of the tibialis posticus and flexor longus digitorum to their inner side, and the tendon of the flexor longus pollicis on their outer side. The order of those parts, counting them from the inner ankle backwards and outwards to the calcaneum, is this: the tibialis posticus, flexor communis digitorum, nerve, artery, and venæ comites, and the flexor pollicis longus. Numerous small branches are given off from the nerve and artery to the neighbouring parts in their course.

The principal varieties of the posterior crural arteries are these—the tibial vessel, in some instances, is larger than usual, while the peronæal is small, or absent; and, in others, the peronæal supplies the place of the posterior tibial, when the latter is diminished in size. The peronæal has been known to take the position of the posterior tibial in the lower part of the leg, and to supply the plantar arteries, or, passing through the interosseous space above the outer ankle, to take the position and form of distribution of the dorsal artery of the foot when the anterior tibial was small, and expended by ramification in the upper part of the leg. In whatever condition the two vessels may be found, there will

Fig. 1.

Fig. 2.

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always be seen ramifying around the ankle-joint, articular branches, which anastomose freely with each other and with those of the anterior tibial.

The popliteal artery is unfavourably circumstanced for the application of a ligature. It is very deeply situated, and the vein adheres closely to its posterior surface. Numerous branches (articular and muscular) arise from it at short intervals; and these, besides being (as some object) a source of disturbance to a ligature, are liable to be injured in the operation, in which case the collateral circulation can be but very sparingly maintained after the main vessel is tied. There is a danger, too, of injuring the middle branch of the sciatic nerve, in the incisions required to reach the artery; and, lastly, there is a possibility of this vessel dividing higher up than usual. Considering these facts in reference to those cases in which it might be supposed necessary to tie the popliteal artery—such cases, for example, as aneurism of either of the crural arteries, or secondary hæmorrhages occurring after amputations of the leg at a time when the healing process was far advanced and the bleeding vessels inaccessible,—it becomes a question whether it would not be preferable to tie the femoral artery rather than the popliteal. But when the popliteal artery itself becomes affected with aneurism, and when, in addition to the anatomical circumstances which forbid the application of a ligature to this vessel, we consider those which are pathological,—such as the coats of the artery being here diseased, the relative position of the neighbouring parts being disturbed by the tumour, the articular branches themselves being involved, and the large irregular wound which would be required to isolate the disease, at the risk of danger to the health from profuse suppuration, to the limb from destruction of the collateral branches, or to the joint from cicatrization, rendering it permanently bent,—we must acknowledge at once the necessity for tying the femoral part of the main vessel.

When the popliteal artery happens to be divided in a wound, it will be required to expose its bleeding orifices, and tie both these in the wound. For this purpose the following operation, usually recommended for reaching the vessel, may be necessary. The skin and fascia lata are to be incised in a direction corresponding to that of the vessel. The extent of the incision must be considerable (about three inches), so as the more conveniently to expose the artery in its deep situation. On laying bare the outer margin of the semimembranosus muscle, while the knee is straight, it now becomes necessary to flex the joint partially, in order that this muscle may admit of being pressed inwards from over the vessel. The external margin of the wound, including the middle branch of the sciatic nerve, should be retracted outwards, so as to ensure the safety of that nerve, while room is gained for making the deeper incisions. The adipose substance, which is here generally abundant, should now be divided, between the mesial line and the semimembranosus, till the sheath of the vessels be exposed. The sheath, which is but a mere cellular envelope, should be incised at its inner side, to avoid wounding the popliteal vein. The pulsation of the artery will now indicate its exact position. As the vein adheres rather firmly to the coats of the artery, some care is required to separate the two vessels, so as to pass the ligature around each end of the artery from without inwards, in order thus to exclude the vein. While this operation is being performed in a case of wound of the popliteal artery, the hæmorrhage may be arrested by compressing the femoral vessel, either against the femur or the os pubis.

In the operation for tying the posterior tibial artery near its middle, an incision of three or four inches in extent is to be made through the skin and fascia, in a line corresponding with the inner posterior margin of the tibia and the great muscles of the calf. The long saphena vein should be here avoided. The mass of the gastrocnemius and solæus muscles requires to be detached from the tibia, and then the knee is to be flexed and the foot extended, so as to relax these muscles, and allow them to be retracted from the plane of the vessels. This being done, the deep fascia which covers the artery and its accompanying nerve is next to be sought for and divided. The artery will now appear pulsating on the flexor communis at a situation an inch from the inner edge of the tibia. In searching for the artery, a mistake as to its situation here is liable to occur in consequence of the operator making his incision between the flexor communis and the tibia, and raising that muscle with the artery and nerve upon it. While the ligature is being passed around the artery, due care should be taken to exclude the venæ comites and the nerve. This is an operation, however, but seldom required. If either of the posterior crural arteries happen to be wounded, the readiest mode of reaching it is in the wound, which would perhaps require to be enlarged, and both ends of the vessel are then to be tied. Aneurism of either of those vessels or of their continuations in the foot seldom, if ever, happens; and when the plantar arteries are wounded, and cannot be reached in the wound, then the posterior tibial should be tied at the situation where it is more readily accessible than under the thick mass of muscles forming the calf, and that situation is behind the lower end of the tibia, between the inner ankle and the os calcis.

Beneath the integuments and subcutaneous adipose tissue on the forepart of the leg and foot, the fascia I I, Fig. 2, is to be seen stretched over the muscles and sending processes between them, thus encasing each of these in a special sheath. The fascia is here of considerable density. It is attached on the inner side of the leg to the spine of the tibia, D, and on the outer side it is connected to the anterior margin of the fibula, and is extended thence over the peronæal muscles to those forming the calf. Between the extensor communis digitorum, B *b*, and the peronæus longus, F, the strong process of fascia which is attached to the fibula, E, and that which joins the spine of the tibia, separate the muscles of the anterior part of the leg from those of the posterior part. Behind both bones of the leg the fascia divides into two layers, which enclose the great muscles of the calf—the superficial layer being thin and transparent, while the deep layer is of considerable density, and binds the deep muscles to the bones and the vessels and nerves to the muscles. In front of the ankle joint, the fascia adhering to both malleoli is increased in density, constituting a band (anterior annular ligament) which extends between the malleoli, forms sheaths for the several extensor tendons, and binds these down in front of the joint. From the lower border of the annular ligament, the fascia is continued over the dorsum of the foot, forming sheaths for the tendons and muscles of this part. Behind the inner malleolus, *c*, Fig. 1, the fascia, H, attached to this process and to the inner side of the os calcis appears as the internal annular ligament, which being broad and strong, forms a kind of arch, beneath which in special sheaths the flexor tendons, and the posterior tibial vessel and nerve, pass to the sole of the foot. On tracing the fascia between the ankles, posteriorly, it will also be seen to divide into two layers—superficial and deep; the former of which adheres to the borders of the tendo Achillis, while the latter passes between this tendon and the deep flexors. Between both these parts of the fascia, a vein may be found to pass up from the inner border of the foot; and it may be that this vessel would, when the artery was being tied, give the false impression that the situation of the artery was already reached if it were not remembered that, in order to expose the latter, the deep layer of fascia has also to be divided. While exposing the fascia on the forepart of the leg and dorsum of the foot, we meet with the musculo-cutaneous branch of the peronæal nerve, which pierces the fascia at about the middle of the limb, between the peronæal and extensor communis muscles, descends superficially in front of the outer ankle and annular ligament, and dividing into branches soon after it appears on the fascia, these traverse in two groups the dorsum of the foot, to be distributed to the integuments of the five toes. On the inner side of the tibia, C, Fig. 1, will be seen the internal or long saphena vein, B B, which, commencing by numerous branches on the dorsal surface of the foot, ascends in front of the inner ankle, to gain the inner side of the leg, after which it ascends behind the inner side of the knee and thigh, till it terminates at the saphenous opening, where it joins the femoral vein. In its course along the lower part of the thigh, the leg and the foot, this vein is closely accompanied by the long saphenous nerve, derived from the anterior crural, and by a group of lymphatics. It is this vessel, and also the short saphena vein, which so commonly appear in a varicose state caused by some mechanical impediment to the venous circulation in the body, such as an enlarged liver compressing the vena cava, a pregnant uterus bearing against the iliac veins, a crural hernia, or an aneurism, or enlarged lymphatic bodies obstructing the femoral vein. Under either of those circumstances, the blood obstructed in its return to the heart, distends the coats of the veins, thereby rendering their valves useless, by separating them from each other. Con-

FIGURES OF PLATE L.

FIGURE 1.—B B, The long saphena vein.—C, The tibia.—D, Tendon of tibialis posticus muscle.—E, Tendon of flexor communis digitorum muscle.—F f, Gastrocnemius muscle and tendo Achillis.—G, Solæus muscle.—H H, Deep layer of fascia, covering the vessels and nerves.—I, Tendon of plantaris muscle.—J J, Venæ comites.—K, Posterior tibial artery.—L, Posterior tibial nerve.

FIGURE 2.—A, Tibialis anticus muscle; a, its tendon.—B, Extensor communis digitorum muscle; b b b, its tendons.—C, Extensor pollicis longus muscle; c, its tendon.—D, The tibia.—E e, The fibula and external malleolus.—F G, Tendons of the peronæus longus and brevis muscles.—H, Tendo Achillis.—I I, Fascia.—J, Peronæus tertius muscle.—K K K, Anterior tibial artery and nerve.—L L L, Extensor brevis digitorum.

sidering the operation of tying those veins (while in that state, and owing to that cause) for the cure of varicose ulcers, and considering, moreover, that all the deeper veins must be in the like state from the same cause, I am at a loss to know the rationale of such treatment. If there be any attending such operation, it must be evident that, in order to give it effect (as the source of the venous current is at the capillaries and as the pressure of the venous blood is from above) the ligature should be placed on the vessel as well close *above* as *below* the ulcerated part.

By removing the fascia from the front of the leg and foot, we expose the several muscles and tendons which are here situated. As all the muscles which have their origins from the thigh-bone have their insertions into the bones of the leg, and thus effect the motions of the latter through the medium of the knee-joint, so we find all those muscles which arise from the bones of the leg, back and front, are inserted into some part of the foot, and act upon this by means of the ankle-joint, at the same time that some of them operate additionally upon the toes, through the intervention of the phalangeal joints. In the upper part of the leg the tibialis anticus, A, Fig. 2, and extensor communis muscle, B, have each an origin from the fascia which covers them, and from the intermuscular septum which divides them. In the lower part of the leg where these muscles and the extensor pollicis, C, terminate in tendons, they are readily separable from one another. The tibialis anticus lies along the outer side of the tibia, from the upper two-thirds of which, and from the head of the fibula, the fascia, and interosseous ligament, it arises tendinous and fleshy. This muscle is superficial in its whole length; its tendon commencing about the middle of the leg, passes in a separate loose sheath of the annular ligament in front of the inner ankle, to be inserted into the inner side of the internal cuneiform bone and base of the metatarsal bone of the great toe. The extensor communis digitorum lies close to the outer side of the anterior tibial muscle, and arises from the upper three-fourths of the fibula, from the interosseous ligament and intermuscular septum. At the lower part of the leg, this muscle ends in three or four flat tendons, which pass together through a ring of the annular ligament, and extending forwards, *b b b b*, over the dorsum of the foot, where they part from each other, become inserted into the four outer toes. The peronæus tertius or anterior, is that portion of the common extensor muscle which is inserted into the base of the fifth metatarsal bone. On separating the anterior tibial, and common extensor muscles, we find the extensor longus pollicis, C *c*, which, concealed between the two, arises from the middle of the fibula, and the interosseous ligament; its tendon passes beneath the annular ligament in front of the ankle-joint, and after traversing the inner part of the dorsum of the foot, becomes inserted into the two phalanges of the great toe. Beneath the tendons of the extensor communis on the instep will be seen the extensor digitorum brevis, L L, lying in an oblique direction, between the upper and outer part of the os calcis, from which, and from the contiguous bones and annular ligament, it arises, and the four inner toes into each of which it is inserted by a small flat tendon which joins the corresponding tendon of the long common extensor. That part of the extensor brevis, which is connected with the great toe, appears as a separate little muscle.

The anterior tibial artery, K, Fig. 2, extends from the upper part of the interosseous ligament which it perforates, to the bend of the ankle-joint, whence it is continued over the dorsum of the foot. In the upper third of the leg, the anterior tibial artery is deeply situated between the tibialis anticus, and flexor communis muscles. Here it will be found, close in front of the interosseous ligament, at about an inch and-a-half in depth from the anterior surface, and removed from the spine of the tibia at an interval equal to the width of the tibialis anticus muscle. In its course down the leg, the vessel passes obliquely from a point close to the inner side of the neck of the fibula, to midway between the ankles. In its descent, it becomes gradually more superficial. In the middle of the leg, the vessel passes between the extensor longus pollicis, and the tibialis anticus muscles. Above, beneath, and below the annular ligament, this artery will be found to pass midway between the extensor pollicis tendon, and those of the extensor communis, and to hold the same relation to these parts in traversing the dorsum of the foot, till it gains the interval between the two inner metatarsal bones, where it divides into two branches, one of which passes forwards in the first interdigital space, while the other sinks between the first and second metatarsal bones, to inosculate with the plantar arteries. The innermost tendon of the short common extensor generally crosses in front of the dorsal artery of the foot near its termination. Between the ankle and the first interosseous space the artery lies comparatively superficial, being here covered only by the skin, fascia, and cellular membrane. Two veins accompany the anterior tibial artery, and its continuation on the dorsum of the foot. The anterior tibial nerve, a branch of the peronæal, joins the outer side of the artery, about the middle of the leg, and accompanies it closely in this position, till both have passed beneath the annular ligament. Both send branches to the several muscles in connexion with them. On the dorsum of the foot the nerve will be found on the inner side of the artery, and in passing to the first interosseous space it gives branches to the extensor digitorum brevis, to the skin of the dorsum of the foot, and ends supplying the integuments of the first and second toes.

The branches of the anterior tibial artery are articular and muscular. From its upper end, which appears perforating the interosseous ligament, arises the recurrent branch which anastomoses in front of the knee with the articular branches of the popliteal artery. Near the ankle, arise on either side of the vessel two malleolar branches, internal and external, the former communicating with branches of the posterior tibial, the latter with those of the peronæal. Numerous small muscular branches arise, at short intervals, from the vessel in its passage down the leg. Tarsal, metatarsal, and small digital branches spring from the dorsal artery of the foot. The anterior tibial artery is rarely found to deviate from its usual course; in some cases it appears of less or of greater size than usual. When this vessel appears deficient, its place is usually supplied by some branch of the peronæal or posterior tibial, which pierces the interosseous ligament from behind.

The anterior tibial artery, when requiring a ligature to be applied to it in any part of its course, may be exposed by an incision, extending for three or four inches (more or less, according to the depth of the vessel), along the outer border of the tibialis anticus muscle. The fibrous septum between this muscle and the extensor communis, will serve as a guide to the vessel in the upper third of the leg, where it lies deeply on the interosseous ligament. In the middle of the leg, the vessel is to be sought for between the anterior tibial and extensor longus pollicis muscles. In the lower part of the leg, and on the dorsum of the foot, it will be found between the extensor longus pollicis, and extensor communis tendons, the former being taken as a guide for the incision. In passing the ligature around this vessel at either of these situations, care is required to avoid including the venæ comites and the accompanying nerve.

The muscles which form the deep layer at the back of the leg, and whose origin there and insertion into the plantar aspect of the bones of the foot render them the flexors of this organ, cannot be seen in their entireties until the muscles proper to the sole of the foot are dissected and removed. Previously to doing so it may not be amiss to make a few observations on the form of the foot as contrasted with that of the hand. Regarding the form of the foot, in this point of view, it is not the object here to prove its adaptation to the erect posture of man, for that needs no proof, while it is so self-evident. But, if by the facts which so clearly illustrate that question, the attention may be turned to cultivate the principle of conservative surgery, a mention of them here will not be out of place.

The foot, in respect to its osseous parts, presents that arrangement of them which declares not only its own particular function, but that configuration of the bones of the lower limb, taken as a whole, which is necessary for the due performance of that function. The foot is adapted to *plantigrade* motion. In its unconstrained position it forms a right angle with the bones of the leg; and the strongest effort of the muscles which move it can only alter that angle to one a little more obtuse in flexion, or acute in extension. Articulating by one of its tarsal bones (the astragalus) with the lower ends of the tibia and fibula, the malleolar processes of these so lock it in as to allow but a very limited degree of lateral motion or rotation; and while directing it to the prone position entirely prevent it assuming the supine. The latter motion cannot be performed by the foot in consequence also of the immobility of the bones of the leg in respect to each other. The tibia (which is the analogue of the radius in all respects beside that of being chiefly articulated with the tarsus as the radius is with the carpus) is developed for the prone position of the foot; is set in that position by its form; is fixed permanently in it by its ligaments, and there exist no muscles in the leg which correspond in function with those which are the supinators of the forearm. With the bones of the leg, that of the thigh conforms; with this the pelvis and spinal column; and with these the head; all segments of the human form, showing separately what all together show with the force of combinate associative evidences, that the form of man, like that of each of the lower animals, is the substantive type of his senses and dominant instincts.

The osseous basis of the foot, like that of the hand, is described as divisible into three sets of parts, viz., the tarsus, the metatarsus, and the

Fig. 2.

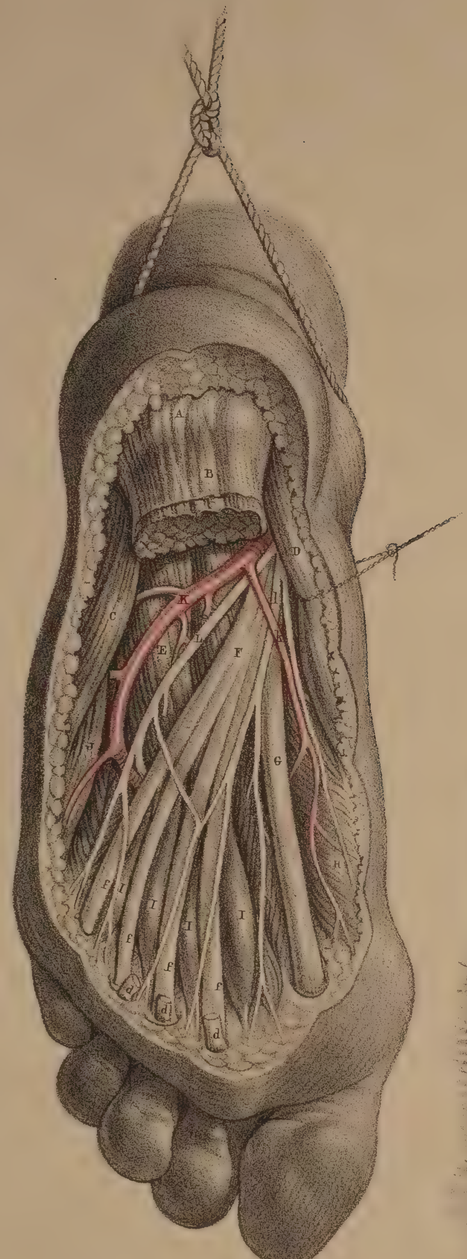


Fig. 1.

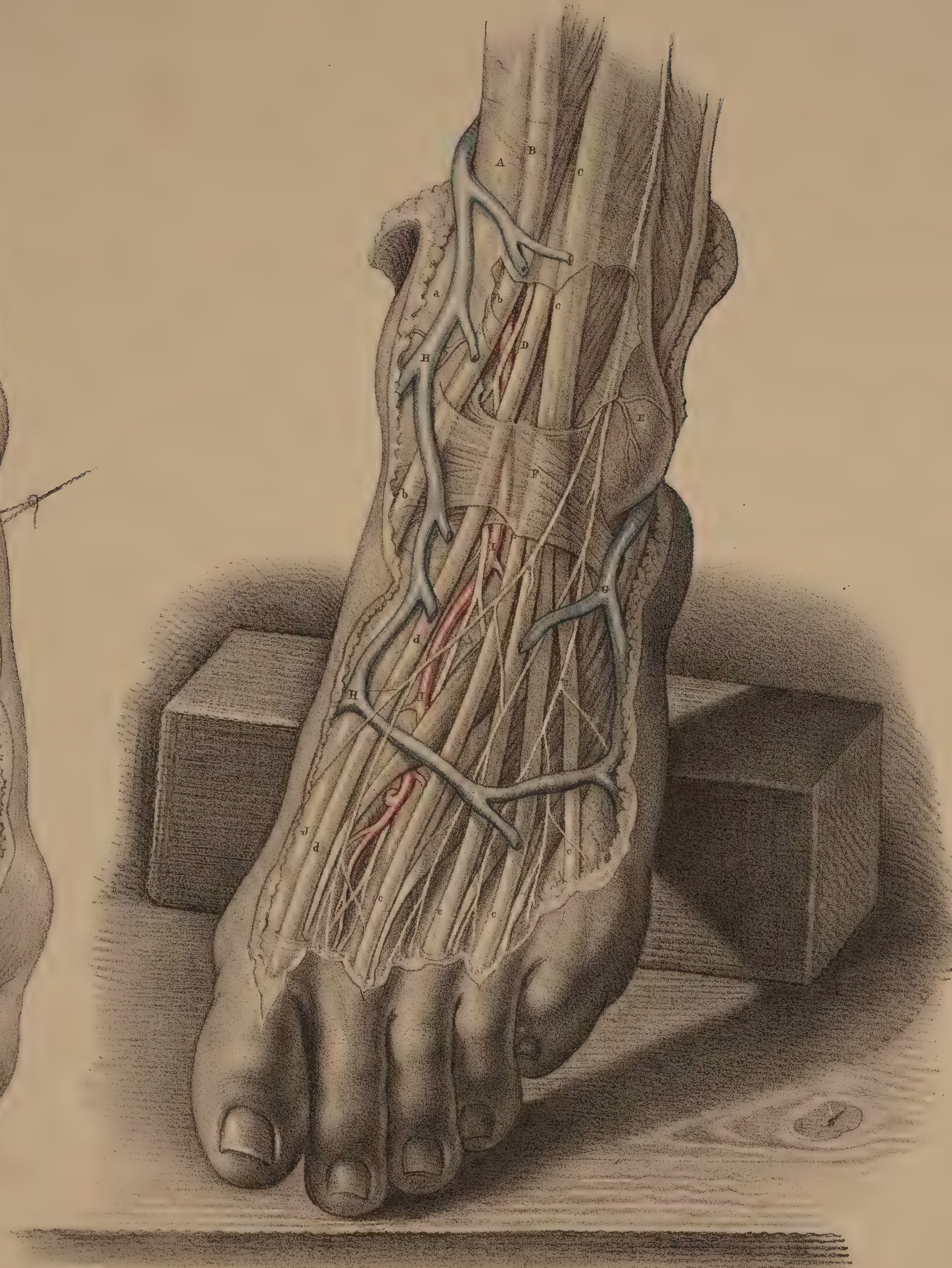
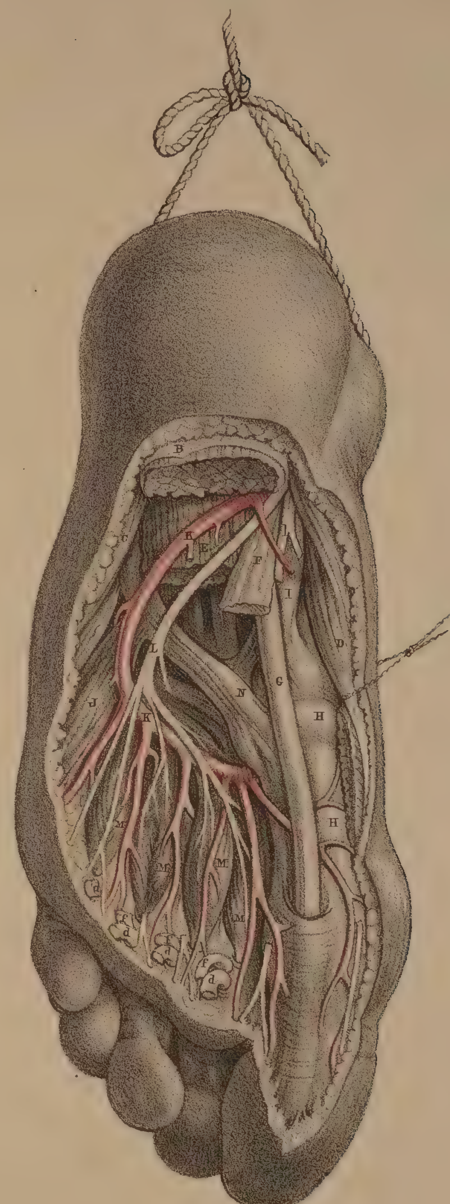


Fig. 3.



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phalanges. The latter are subdivided into three sets also—a first, a second, and a third. In this will be noticed the transverse divisioning of the foot, but this is artificial, for, naturally, those divisions are connected end to end by ligaments which, while admitting of motion, bind the bones together in serial rank. Naturally, the foot, like the hand, is formed on the principle of radiation, into five individual members—each of which consisting of jointed parts—the last, the second, and the first phalanx, the metatarsal bone and one of the tarsal, represents a form *per se*, and only associated with the four others for united motion. While the elemental parts of the foot are represented in the hand, and yet both members present respectively such peculiarities of form as exist, it is only by a comparison of the two that we may fully recognise those differences, and know on what mode of development they depend. The great size of the tarsal bones, and especially of the astragalus and os calcis, compared to the carpal bones, constitutes a chief difference between the forms of the foot and hand. The astragalus is so large that it equals by its articular upper facet the articular surface of the tibia, and excludes the other tarsal bones from the tibio-tarsal joint, whereas the first row of the carpal bones are so small that together they enter into the formation of the radio-carpal joint. The os calcis receiving on its upper anterior face the lower articular surface of the astragalus, projects like a spur horizontally behind the bones of the leg, and forms the heel, of which in the hand we find only a rudimentary analogue, viz., the pisiform bone; but in the lower animals (Solipeds and Ruminants) the pisiform bone projects behind the carpus like their os calcis, and is not much smaller in size than this; and thus it appears that, as by a quantitive equalization of both those bones, the fore and hinder limbs of those animals are rendered more similar, so in the human hand and foot, on the quantitive difference between those bones depends very much the special differential characters of those members. In not a less degree than by the features just mentioned, is the foot rendered different from the hand by the form, position, and use of the bones of the great toe contrasted with those of the thumb. The metatarsal bones are very similar to the metacarpal in form, and are of the same number; but while the metatarsal bone of the great toe stands fixedly sidelong with the four others, the metacarpal bone of the thumb is depressed towards the palm of the hand, projects apart from the four others, and, having an independent motion by means of a special muscular apparatus, is capable of opposing its phalangeal appendage to those of the other digits, thus constituting the hand a prehensile organ, while the want of that special modification of the metatarso-phalangeal series of bones answers for the fitness of the form of the foot as a basis of support and an organ of progression. To these functional peculiarities of both organs, respectively, the length and pliability of the fingers, and the shortness and comparatively restrained motion of the toes, greatly contribute; for while the thumb and any one finger (the hand being deprived of all the other fingers) may still exert prehensile action, the great toe, incapable of opposing its fellows, requires not such a length of them as to equal that of the fingers, and hence we find them, from within outwards, decreasing in size, exactly in accordance with their lessening functional value—a fact, which in itself renders the foot more suited to progressive motion.

The foot, by this peculiar coaptation of its osseous parts, and by their relative proportions and differences as to size compared with those of the hand, presents itself of an arched form, convex at the dorsal aspect, and concave at the plantar. This arched shape is chiefly due to the large size and projecting position of the os calcis, which, by lifting the metatarsal bones behind, receives, itself, the weight of the body, and throws it forwards on their phalangeal ends. By that articular union of several bones which gives this arched form to the foot, three principal uses among others of lesser note are served, viz., elasticity of support to the superincumbent weight, a favourable condition for leverage and forward motion, and a recess for locating the plantar muscles, vessels, and nerves, where pressure cannot injure them or hinder their functions.

The sole of the foot, Plate LI., Figs. 2, 3, is covered by a hard and thick integument, beneath which will be seen a large quantity of granulated adipose tissue so intersected by bands of fibrous structure as to form a firm, but elastic cushion, in the situations particularly of the heel and metatarso-phalangeal joints on which the weight of the body presses. On removing this structure, we expose the plantar fascia, B, Fig. 2, extending from the os calcis, A, to the toes. This fascia, consisting of transverse and longitudinal fibres, is remarkably strong, especially its middle and outer parts, which, like ligaments, serve to retain the arched form of the foot, and thereby to protect the plantar structures from superincumbent pressure during the erect posture. The superficial plantar muscles become exposed on removing the plantar fascia, to which they adhere. They form three fleshy masses—an outer, an inner, and a middle one, separated from each other by septa formed of the plantar fascia. In the centre will be seen the thick fleshy flexor digitorum brevis muscle, arising from the inferior anterior part of the os calcis, and passing forwards to divide into four small tendons, *d d d d*, which are inserted into the second phalanges of the four outer toes. On the inner side of the foot appears the abductor pollicis, D, arising from the inner side of the os calcis and internal annular ligament, and passing to be inserted with the flexor pollicis brevis, H, into the sesamoid bones and base of the first phalanx of the great toe. On the external border of the foot is situated the abductor minimi digiti, C, arising from the outer side of the os calcis, and passing to be inserted with the flexor brevis minimi digiti, J, into the base of the first phalanx of the little toe. When the flexor brevis digitorum muscle is removed, the plantar arteries, L M, and nerves, are brought partially into view; and by separating the abductor pollicis, D, from its origin, their continuity with the posterior tibial artery and nerves, behind the inner ankle, will be observed. The long flexors with which the vessels and nerves are in connexion should now be examined.

The flexor digitorum longus, situated behind the tibia, arises from the surface of that bone below the insertion of the popliteus, and as far down as a point a few inches above the inner malleolus, where its fibres end in a tendon which passes behind the malleolus internal to the vessels and nerves, and thence turning forwards and outwards in the sole of the foot expands here, and divides into four tendons which pass forwards to be inserted into the last phalanges of the four outer toes. Under the articulations of the first and second phalanges, where the tendons are each bound by a strong fibrous sheath, they pass through the slit tendons of the flexor digitorum brevis. In the sole of the foot appears a remarkable fleshy mass of muscle, which, arising from the lower anterior part of the os calcis, above the origin of the flexor digitorum brevis, is inserted into the contiguous margin of the tendon of the flexor digitorum longus, and evidently for the purpose of rectifying the oblique action of the latter muscle approaching the toes from the inner ankle. The flexor pollicis longus, a muscle of large size and strength, arises from the lower three-fourths of the fibula, and forms its tendon opposite the tibio-tarsal joint, behind which it passes external to the vessels, and enters the sole of the foot above the tendon of the long common flexor; and, passing close to the inferior surfaces of the first metatarsal bone and its phalanges, to which it is bound by a fibrous sheath, is inserted into the last phalanx of the great toe. The tibialis posticus, situated between the bones of the leg and the two last described muscles, arises from both those bones and from the whole surface of the interosseous ligament; forms its tendon behind the inner ankle, and passes its own tendon between that of the flexor digitorum longus and the tibia to become the innermost of the parts behind the internal malleolus, and proceeds thence to its insertion into the plantar border of the scaphoid and contiguous bones of the tarsus. The tendons of all these long flexors play in bursæ, where they pass behind the tibio-tarsal articulation. On the outer side of the leg appear the peronæi muscles which, like the long flexors, act upon the foot through the medium of the ankle-joint. The peronæus longus arises subcutaneously by fleshy fibres around the head of the fibula, and from the upper half of the external side of that bone, from the fascia which invests it and from the intermuscular septa which separate it in front from the extensor communis, and behind from the

FIGURES OF PLATE LI.

FIGURE 1.—A a, The tibia and internal malleolus.—B b, Tendon of the tibialis anticus.—C c, Tendon of the extensor communis digitorum.—D d, Tendon of the extensor pollicis.—E, External malleolus.—F, Annular ligament crossed by the cutaneous branches of the musculo-cutaneous nerve.—G, Origin of short saphena vein.—H H, Long saphena vein.—I, Dorsalis pedis artery and nerve.—J, Metatarsal bone of great toe.

FIGURE 2.—A, Os calcis.—B, Plantar fascia and muscle cut.—C, Abductor minimi digiti.—D, Abductor pollicis.—E, Flexor accessorius muscle.—F f f f, Tendon of flexor longus digitorum communis muscle.—G, Tendon of flexor longus pollicis muscle.—H, Flexor brevis pollicis muscle.—I I I I, Lumbricalis muscles.—J, Flexor brevis minimi digiti.—K k, External and internal plantar arteries.—L l, External and internal plantar nerves.

FIGURE 3.—Other parts lettered as in fig. 2.—H, Metatarsal bone of great toe.—I, Tendon of tibialis posticus muscle.—K, Deep plantar artery and interosseous branches.—L, Deep plantar nerve and interosseous branches.—M M M M, Interosseal muscles.—N, Tendon of peronæus longus muscle.

muscles of the calf of the leg. About the middle of the leg this muscle forms its tendon, which, passing straight down behind the outer malleolus to which it is bound by a process of the annular ligament, advances thence forwards and inwards between the plantar muscles and the tarsal bones, and is inserted into the base of the metatarsal bone of the great toe, where it forms a sesamoid bone and radiates to other connexions. The peronæus brevis, beneath the former muscle, and more fleshy than it, arises from the posterior surface of the lower half of the fibula; forms its tendon behind the outer malleolus, to which it is bound in the same groove with the peronæus longus, and thence passes to be inserted into the base of the external metatarsal bone and the cuboid. Of the other muscles situated in the sole of the foot, few or no remarks of surgical interest can be made. Their names of flexors, abductors, and adductors, are not so applicable to them as to their counterparts attached to the freely moveable bones of the hand. The actions of the plantar muscles are united for gathering and sustaining the osseous elements of the foot in the standing posture, and during progression; as to distinct actions, they have none; and of this, the existence of the transversalis pedis muscle and ligament binding the heads of the metatarsal bones together, is a proof; while the relative positions and the other ligamentous connexions of the bones are of themselves sufficient evidence of the fact, and characterising the foot as a motionary pedestal.

The plantar branches of the posterior tibial artery are the internal and external, both of which are deeply placed between the superficial and deep plantar muscles. The internal plantar artery, K, Fig. 2, is much the smaller of the two, and expends itself on the muscles and integuments of the great toe. The external plantar artery, K, is large, and seems to be the proper continuation of the posterior tibial. It corresponds, in the foot, to the deep palmar arch in the hand. Placed at first between the origin of the abductor pollicis and the calcaneum, the external plantar artery passes outwards between the short common flexor, and the flexor accessorius, E, to gain the inner borders of the muscles of the little toe; from this place it curves deeply inwards between the tendons of the long common flexor of the toes, F *f f*, and the tarso-metatarsal joints, to gain the outer side of the first metatarsal bone, where it anastomoses with the dorsal artery of the foot, H, Fig. 3. In this course it is covered in its posterior half by the flexor brevis digitorum, and in its anterior half by this muscle, together with the tendons of the long common flexor, F, Fig. 2, of the toes and the lumbricales muscles, I I I I. From the external plantar artery are derived the principal branches for supplying the toes and the structures in the sole of the foot. The posterior tibial nerve, after passing behind the inner ankle with the artery to enter the sole of the foot, divides into two branches—the internal and external plantar. The internal plantar nerve, I, divides into four branches, for distribution to the four inner toes, to which they pass between the superficial and deep flexors. The external plantar nerve, passing along the inner side of the corresponding artery, sends branches to supply the outer toe and adjacent side of the next, and then passes, with the artery, between the deep common flexor tendon and the metatarsus, to be distributed to the deep plantar muscles. This arrangement of the plantar vessels and nerves corresponds very exactly with that of the like parts in the palm of the hand:—that nerve which supplies the lesser number of digits, and the greater number of the deep seated muscular parts accompanies that artery which supplies the greater number of digits while that nerve which is distributed to most of the digits follows that artery which serves the fewer of them. In the fact, too, of both nerves and arteries dividing into digital branches near the interdigital clefts for supplying the contiguous sides of two digits, a similarity in the anatomy of the hand and foot is evident, and, moreover, the arteries and nerves on the dorsum of each member are of smaller size than those at its opposite aspect.

The posterior tibial artery may be tied behind the inner ankle, on being laid bare in the following way:—A curved incision (the concavity forwards) of two inches in length, is to be made midway between the tendo Achillis and the ankle. The skin and superficial fascia having been divided, we expose the inner annular ligament, consisting of two layers, the deeper of which will be found enclosing the vessels and nerve in a canal distinct from that of the tendons. Their fibrous sheath having been slit open, the artery will be seen between the venæ comites, and with the nerve, in general, behind it.

When any of the arteries of the leg or the foot are wounded, and the hæmorrhage cannot be commanded by compression, it will be necessary to search for the divided ends of the vessel in the wound, and to apply a ligature to both. The expediency of this measure must become fully apparent when we consider the frequent anastomoses existing between the collateral branches of the crural arteries, and that a ligature applied to *any one* of these above the seat of injury will not arrest the recurrent circulation through the vessels of the foot.

A general survey of the form, course, and distribution of the crural arteries will explain the anatomical principle on which the foregoing observation is founded. The three crural arteries—anterior and posterior tibial, and peronæal—spring in the popliteal space from the one main trunk, and following their several courses down the leg, terminate in the foot, where they communicate by inosculation with each other. In this particular the vessels represent a circle, of which, if any part be severed, the issue of the arterial current must necessarily take place as well from the patent orifice of the distal part as from that of the proximal, though it be true that the flow from the latter, as being direct from the parent vessel, must occur with greater force and speed than that from the former, which only receives its blood indirectly through collateral channels, in which, owing to their small size and frequent branching, the heart's impulse to the blood must consequently be weakened. This fact is observable in all cases of wounds of arteries—the flow through the distal portion of the divided vessel not occurring in the manner of *saltation*, but uniformly, like that from an opened vein. But though, as a precautionary measure, the deligation of both ends of the divided artery should, in all instances, be adopted, it is true that the necessity for it is less urgent in respect to the crural arteries than those of the forearm; for in the latter the anastomoses of the vessels are not only more frequent, but by more considerable branches than are found in the leg. The peronæal artery which represents the ulnar does not (like the latter vessel which gives off the digital branches and freely anastomoses with the radial, in the palm and elsewhere) join any considerable branch of the posterior or anterior tibial in the foot, but expends itself by branching over the external malleolus and outer side of the os calcis. The posterior tibial, which represents the radial, is (unlike the latter vessel, which but partially supplies the hand and freely anastomoses with the ulnar) almost the only source of supply to the structures in the sole of the foot, and only presents, as the most notable point of anastomosis with the other two vessels, that (the ramus communicans) which joins the branch of the dorsal artery of the foot through the first interosseous space of the metatarsus. Hence, of the crural arteries it may be said, that when any of them has become the subject of deligation, not only is there a less probability of recurrent hæmorrhage, but that, its direct circulation being arrested, the parts which it was destined to serve have but a very few other sources of support.

Of the ligamentous apparatus which connect the bones of the foot to each other, and the foot, as a whole, to the bones of the leg, a few general remarks will suffice for present purposes. Like the ligaments which bind together the other joints of the skeleton, those of the foot indicate the motions which its joints can admit of; but, in addition to this, the ligaments of the foot show, by their strength at particular positions, and especially at the plantar surface, that they are intended to serve another use—that of sustaining the weight of the body where the bones, instead of standing in the erect posture, perpendicularly end to end, in the line of gravity, as the condyloid head of the femur does on the head of the tibia, jut from that line like the walls of an arch, and require binders, in the absence of buttresses, to maintain them in their integrity. The tibio-fibular articular facet is applied vertically to the upper surface of the astragalus, and the two malleoli projecting downwards on either side of the joint, admit of but a slight degree of lateral motion; and here we find the lateral ligaments binding the ankle-joint together, while anteriorly, in order to admit of the full extension of the foot, a restraining ligament does not exist. The anterior and posterior divisions of the external lateral ligament are horizontal between the malleolus and the astragalus, and do not, therefore, limit the flexion and extension of the joint, which is designed principally for those motions, as is further rendered evident by the position of the flexor and extensor muscles. While the astragalus, situated thus directly under the tibia, supports the weight of the body in the line of gravity, we find, on the contrary, that the astragalus articulates with the scaphoid bone in front, and with the os calcis below and behind; both these latter bones thus projecting in opposite directions—anteriorly and posteriorly—from each other, with a tendency of the astragalus, from superincumbent weight, to sunder them still further, and thereby flatten the arch of the foot, which it must do (in the same way as pressure upon the arc of a bow would flatten that arc, by further separating its extremes, but for the cord which connects and sustains them) were it not for the presence of the strong plantar ligaments, which prevent that occurrence. At the dorsum of the foot the tarsal bones (the scaphoid cuneiform and cuboid) are broader than they appear at their plantar aspect: like the stones

of an arch, they are cut wedge-shaped, and being bound together by the ligaments, they thus secure the convexity of the instep, by which the concavity of the sole results. The ligaments on the dorsum and sides of the foot form, together, a woof of fibrous bands, which connect in every direction the contiguous bones; at the plantar surface the same bones are, in a similar manner, connected by short bands crossing from one to the other, and between them there are interosseous ligaments. But in the sole of the foot we find, in addition to these, certain ligaments of remarkable size and strength, which demand especial notice. The calcaneo-cuboid ligament consists of two layers of fasciculi—a superficial and a deep one,—of which the former (ligamentum longum plantæ) is extended between the lower surface of the anterior part of the os calcis and that of the cuboid bone, from which its fibres are continued forwards to be connected, also, with the bases of the five metatarsal bones, while the deep fasciculus, broader than the other, passes directly from the os calcis to the cuboid. The calcaneo-scaphoid ligament, short, but remarkably strong, attaches the os calcis to the scaphoid bone, and, lined by the synovial membrane on its upper surface, forms part of the articular fossa which receives the anterior facet of the astragalus, and effectually supports this bone under the weight of the whole body, at the same time that, with the long plantar ligament, it preserves the arch of the foot, and admits of a certain degree of elasticity, to obviate the effects of sudden shocks. Considering the skeletal foot, thus perfected as to its mechanism—being a basis of support by reason of its broad arch; an elastic basis by reason of its consisting of numerous osseous elements bound together by ligaments, and yet in some degree articularly moveable on each other; and an instrument of progression by reason of its being placed at right angles with the bones of the leg, beneath which it may be moved like an horizontal lever of the second class,—it might, in regard to the first-mentioned fitness (the two others being additional fitnesses, the plurality of which marvellously characterise the construction of all organic design), be not inaptly likened, by its form and properties, to the half of a shallow dome standing on its semi-circular basis, as represented by the anterior ends of the metatarsal bones in front, the os calcis behind, and the metatarsal bone of the little toe, with the cuboid bone and os calcis outside. Of this semidome, the open side (arched, and rising from its extremes) is represented by the tarso-metatarsal span of the great toe, and the bones comprising which are the more massive, as being the chief support to the superincumbent weight. That this is the geometrical signification of the form of one foot—that it is as a half of an entire concave figure,—is further proveable on setting the two feet in apposition by their inner sides, when we see them constituting a perfect vault, of which the gravitating centre is between the two astragali, and the line of bipartition of that symmetrical entirety is ranging, antero-posteriorly, between the inner borders of both feet.

Having those ideas as to the functionally perfect form of the foot, we are enabled, while contrasting with it the various kinds of its deformities, to estimate these in their true character, according to the proximate anatomical causes to which they are attributable.

The foot is subject to various malformations—congenital and pathological—which admit, with more or less probability of a successful result, a treatment by operative measures. The congenital malformations present greater varieties than the pathological, as respects the shape of the member from distortions of its skeletal parts. Of the latter kind the following are examples: a flattening of the foot, in which the instep is depressed, and the plantar arch obliterated, owing to a lowering of the tarso-metatarsal bones to such a degree that they occupy the same plane. The structures principally at fault in this condition of the foot are the inferior calcaneo-cuboid and scaphoid ligaments, which have yielded beneath the weight of the body, and allowed the astragalus—the key-stone of the plantar arch—to be impelled downwards, as a consequence of which the inner malleolus touches the ground, in the erect posture, while the outer border of the foot appears in some degree turned up. For such a case, if any benefit is to be derived from a supporting apparatus, it is evident that the erect posture must frustrate the desired result, while the part to be supported by the apparatus, and the parts from which it supports, are parts of the same member, all bearing down together. In this remark I indicate the inefficiency of every apparatus which I have seen, intended for support and the reduction of the displaced parts. Another not uncommon deformity is the distortion of the toes, one or more of them being permanently elevated over the others, and all impressing each other to such a degree, that their natural forms are wasted, and their separate actions obstructed. The cause of this state is said to be, in most instances, a contraction habitually exercised by the extensor muscles; and the remedy proposed, on that belief, is a division of one or more of the tendons of those muscles. But if such a deformity be attributable to a long-continued compression of the parts, it appears to me that not the tendon, but the fibrous structures of the digital joints, are in the first place at fault, by having become thickened from friction, and fixing the digits in the position described. A permanent contraction of the toes does not give rise to such inconvenience as the like state in respect to the fingers; for the quiescent position of the former is one rather of flexion than extension, since flexion is the action of the toes, whether in standing or in progressing. Corns and bunions are usually found connected with the digital joints, because pressure is more commonly exerted on those parts; and the joint becoming thereby partially dislocated, the ends of the bones forming it project. Those affections may arise in connexion with any joint of the skeleton, as instanced in individuals whose occupations subject this or that particular part of them to rough usage. A corn or a bunion is a pathological state only when it is inflamed: in the first stages of their formation they are but provisions of nature to obviate friction,—the integument of the part becomes thickened, and between it and the joint a bursa is produced, to facilitate motion. Such formations are natural to some of the lower animals. The callosities of the camel are examples.

The congenital deformities of the foot generally involve the whole of its osseous parts. In looking for the cause of those deformities, the ultimate fact appears to me to be an imperfect—an irregular development of the bones of the foot, some of which increase to unnaturally larger proportions than others, and the places which the latter, stunted in growth, should have occupied, are intruded upon by the former. As this condition is assumed in uterine life, the cause of the malformation can be no other than defective development of the bones primarily, and of the muscular apparatus secondarily; for the muscles endowed *ab origine* with a power of tonic contractility, assume a length in the exact measure of the distance between their several origins and the distorted parts into which they are inserted; and their wasted, shortened proportions, and rigid characters, are due to the circumstance that the deformity, having become fixed by the strengthening ligaments, renders the muscles incapable of that normal action which would increase their normal dimensions and power. Of the truth of this remark we find a proof in the immediate effects of the operation of tenotomy. The distortion of the member is not immediately reducible by the mere division of the tendons of the muscles which are supposed to have caused it, though it be most true, that without such an operation, it would be in vain to endeavour, by the use of any apparatus, to overcome the resistance offered by the ligamentous structures of the joints, and that which arises from the ill-set coaptation of the articular facets of the bones.

The principal and extreme varieties of deformities of the foot are three in number,—viz., 1st, that in which the heel is permanently elevated, the tarso-metatarsal bones appearing in a vertical line with the bones of the leg, and the phalangeal bones forming a right angle with the others, and becoming alone the horizontal basis of support in the erect posture; 2nd, that in which the heel is permanently elevated, at the same time that the foot is twisted inwards, so that it rests on its outer side, the inner side and great toe not coming in contact with the ground in the erect position; and 3rd, that in which the foot, in the standing posture, rests on its inner side, while the outer side and heel are elevated from the ground. Of these complete malformations respectively, there are varieties of intermediate degrees. Of the three deformities, the second mentioned is the most common, the first less so, and the third but rarely met with. The *first*, which is a digitigrade foot, and termed *talipes equinus*, presents itself of a form which (supposing it to be induced by muscular action) indicates the agency of the great muscles of the calf in chief, and aided by that of the peronæus longus muscle, whose point of insertion in the sole of the foot renders it a flexor; and the same may be said of the tibialis posticus, as also of the flexor communis and flexor pollicis, for these, though exercising a special action on the toes, serve, at the same time, to flex the whole foot, through the medium of the ankle-joint, when, as in progression, the toes are fixed in grasping the ground. The *second*, named *talipes varus*, as plainly indicates the muscles to whose action the deformity corresponds: the heel is elevated by the muscles of the calf, while the inner side of the foot is raised inwards by the action of the tibialis anticus, and in some measure also by the extensor pollicis. The *third*, named *talipes valgus*, would appear to express (if of any muscles) the action of the peronæus tertius and brevis; but of this deformity, more especially than of the others, it may be said that the parts chiefly at fault are the bones and ligaments. While the classes of muscles now noticed may be regarded as retaining respectively the several forms of club-foot, if they be not

the prime agents in inducing them—the action of the short plantar muscles, and also a shortening of the plantar fascia, contribute in no small degree to the same defects. The operation of dividing the tendons of those muscles which are considered to be at fault, is to be conducted according to the anatomical relations of the parts as above specified.

Besides the class of congenital malformations of the foot now noticed, and which are characterizable either as deformities in respect to one or more parts of the foot, or to that organ as a whole, there is another very remarkable class, in which they present themselves either as *excess* or *defect* compared with the normal number of digits. The human hand, as well as the foot, give instances of this kind of aberration from the usual type of either member, and prove this type in respect to the number (quinque) of digits to be but as a mean proportional. Of the two members, however, the foot is that in which the greatest degree of excess of digits is liable to appear, and as if it were more subject to the law of radiation in regard to its terminal appendages than the hand is. The adult foot I have seen, more than once, exhibiting digits *eight* in number (and have heard of an example of the organ having *nine*), all perfectly formed, with the proper number of phalanges. The metatarsal bones also were eight in number, and the tarsal row (including the cuboid bone), with which those digits articulated in the usual form were six in number, there having been five cuneiform bones. In another instance, in which there appeared *seven* digits, and in another *six*, each digit having its proper number of phalanges, there was a corresponding number of metatarsal bones; and in that foot with seven digits, there were four cuneiform bones with the cuboid; while in that with six digits, there was but the normal number of three cuneiform bones with the cuboid. In the dissection of each of those feet, the tendons of the extensor and flexor muscles equalled in number those of the digits, and were attached to them in the ordinary way, while the foot, as a whole, retained its normal configuration and functional fitness; and its fellow of the opposite side presented in all respects the same peculiarities. While such are the anomalies which, compared with the normal form of the member, may be regarded as examples of simple excess, and having the surplus parts anatomically constituted like the normal parts, there occur others which, compared with the normal form, represent instances of simple defect. The foot, like the hand, occasionally exhibits but *four* digits, *three*, or only *two*, and even but *one*, with a corresponding reduction in the number of the metatarsal bones, and a similar reduction in the tarsal row to which these are immediately connected. Thus, then, in a decreasing series (9, 8, 7, 6, 5, 4, 3, 2, 1) of digital appendages we mark the normal number of *five* as appearing midway; and while, in comparison with five, we account all excess and defect of digital development as anomalous in the human form, we have but to extend our comparison through the lower species and we shall find that all the varieties of their corresponding organs, both normal and abnormal, simply result as different proportionals of the selfsame series.

On considering in how far the foot is rendered less functionally efficient according to its quantitive losses by amputation, we shall find that the parts owing to whose removal the hand becomes less effective as a prehensile organ, are the analogues of those by whose removal the foot is deprived of its fitness as an organ of progression. What the thumb is to the hand the great toe is to the foot, namely, a part which, *per se*, surpasses in value any other single digit, and which increases in value according to the number and proximity to itself of those which accident or design leaves remaining to the member. The relative value of the digits of the foot is indicated in their relative proportions and positions. The great toe is the appendage of the more massive and the longest tarso-metatarsal base, which at the inner side of the foot forms the highest part of its arch, and is directly under the tibia which transmits the whole weight of the body; whereas, according as the other toes, with their respective tarso-metatarsal bases, are removed more and more external to the direct line of gravity, their proportions, both as to length and strength, are gradually diminished, and in a corresponding gradation the arch of the foot becomes less and less marked, till the bones forming its outer side lie parallel with the ground. In this configuration we may judge of the relative functional value of the digits and their respective tarso-metatarsal bases: that it is in the ratio of their quantitive degeneration from within outwards, and so, likewise, is the loss which the foot sustains by the deprivation of them. While this observation holds true in whatever degree the member may require to be truncated, it lends support to the principle—that in amputation of the several parts of the foot as much as possible of the member should be spared, with a view to render it still as effective a lever as may be, under the action of the muscles, and as an organ of support.

When the last phalanx of the great toe is removed, the long flexor tendon being then divided, the power of flexing the first phalanx is lost, while this remains still under the control of the long and short extensor, which, having no antagonist (for the short flexor cannot efficiently serve that office), project the first phalanx permanently upwards, and thereby render it of little use for progression. If the tendon of the long flexor happens not to retract altogether, it contracts adhesions to the first phalanx, and may act upon this part, and thus counteract extension. When the first phalanx of the great toe is amputated, the tendons of all its muscles are divided, without, however, affecting the uses of its metatarsal bone; for this may still maintain the arch of the foot for support and for leverage in progression, though the latter use is materially diminished by the loss of its phalangeal appendage. But when the metatarsal bone is also amputated, the foot, by the loss of its sustaining arch, undergoes a privation, both as respects its power of progression and support, to a greater extent than it would if, while the metatarso-phalangeal quantity of the great toe remained entire, it were deprived of all the rest. Of the other digits it may be remarked, that when the last phalanx of either of them is amputated, though both the long extensor and flexor tendons are divided and retracted, still, by the insertion of the tendons of the short common flexor into their second phalanges, these obey the action of this muscle and hold their natural position.

In cases requiring transverse amputations of the foot through its several segments, due regard is to be had as well for the use which the remaining part may serve, as for the entire removal of the diseased or mutilated part. When all the digits are amputated at the metatarso-phalangeal joints, the tendons of all the muscles which moved them are divided, and those tendons, contracting connexions at or near the cicatrised wound, still act as extensors and flexors of the foot, which, having its complete arch and the entire length of its lever still preserved (for the digits constituted no part of either), acts yet as a very efficient organ for support and progression. All further degrees of truncation of the member reduce it to the character of a mere moveable pivot, and the whole limb to that of a jointed pedestal whose progressive motion is a halt. When the foot is reduced to the tarsus, this part is moveable by the action of the gastrocnemius, the solæus, the peronæus, and the anterior and posterior tibial muscles; but those muscles, and particularly those which have had their insertions into the metatarsus and phalanges, undergo a wasting according as they are less required for effecting the motions of progression, as performed by the perfect member. When amputation is performed at or immediately above the ankle-joint, all the muscles which have their origin in the bones of the leg are, of course, rendered inoperative in consequence of the removal of the foot which they were destined to move through the medium of the ankle-joint, and, in process of time, an almost total degeneration of them is the consequence. This degeneration is manifested in the solæus; but the gastrocnemius, having its origin in the condyles of the femur, and its severed tendo Achillis becoming united to the bones of the leg at or near the site of amputation, retains in great part its muscularity as a flexor of the knee-joint, and as one of the antagonists of the extensor muscles inserted into the tubercle of the tibia through the medium of the patella.

Fig. 1.

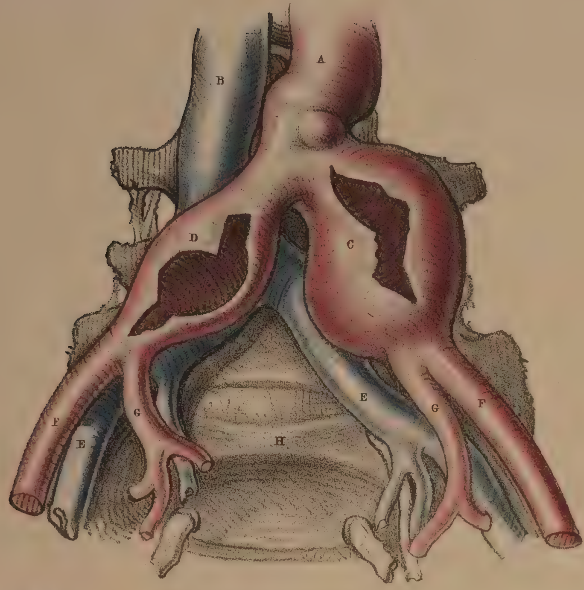


Fig. 2.

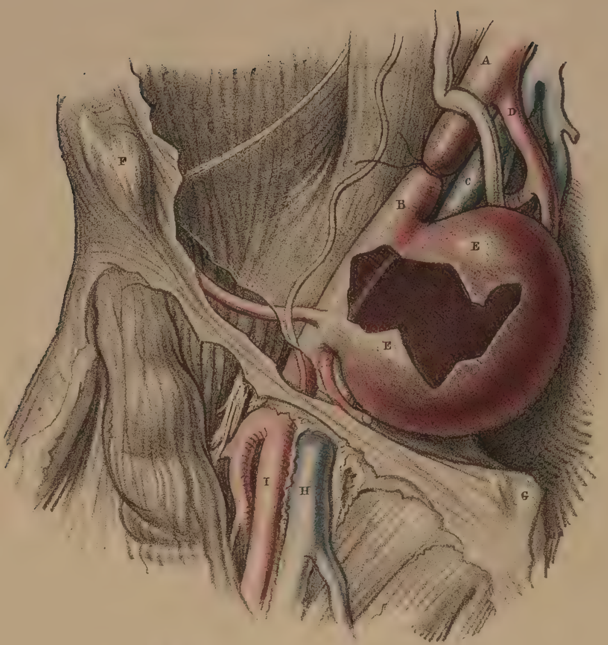


Fig. 3.

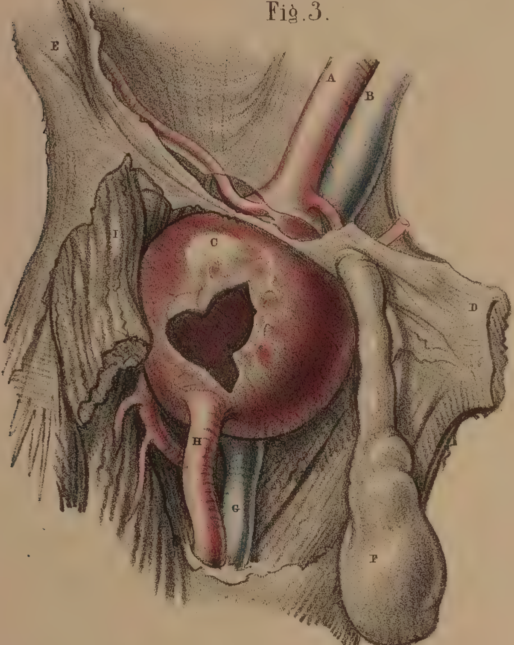


Fig. 4.

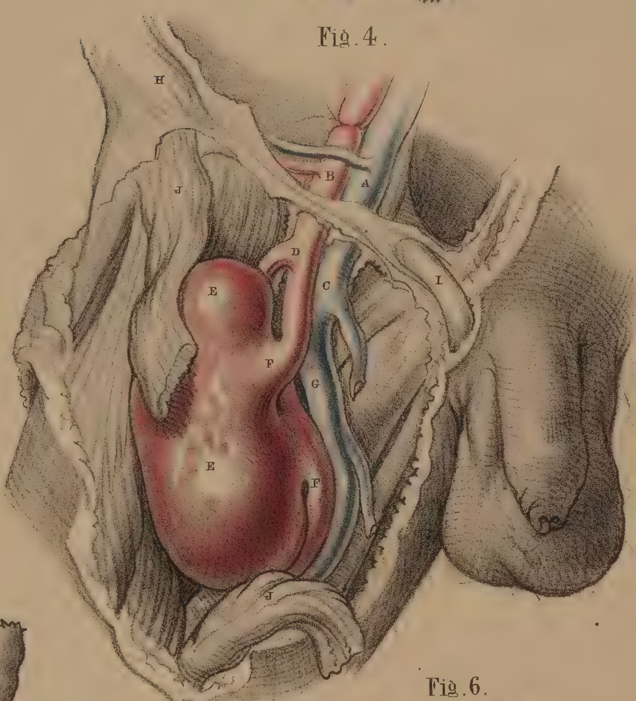


Fig. 7.

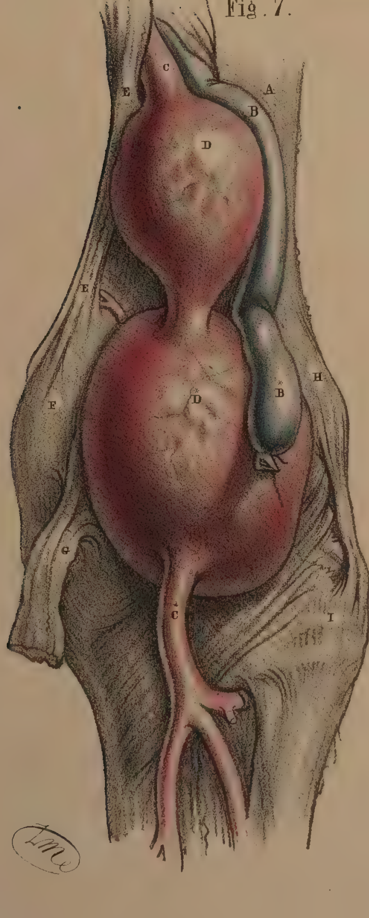
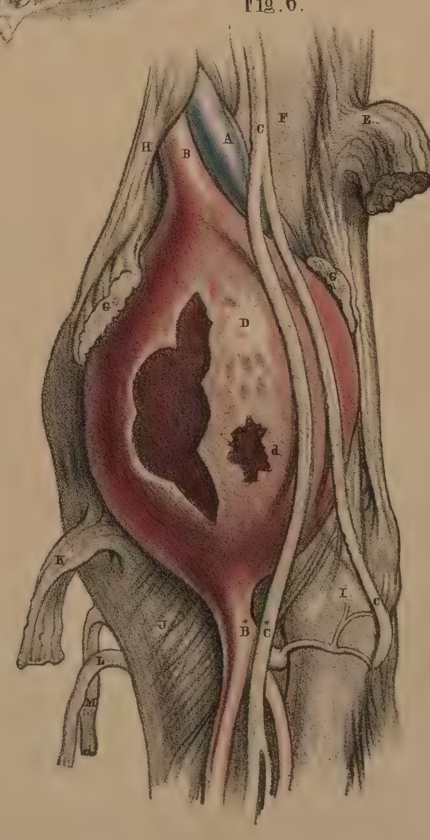


Fig. 5.

Fig. 6.



M & N. Hanhart, Imp.

COMMENTARY ON PLATE LII.

ANEURISM OF THE COMMON ILIAC, EXTERNAL ILIAC, COMMON FEMORAL, FEMORAL AND POPLITEAL ARTERIES THEIR RELATIVE ANATOMY AND OPERATIVE TREATMENT.

In describing aneurisms of the neck and upper extremity, I offered an explanation of their causes, form, effects, symptoms, and treatment, according to the views I entertain respecting the circulating forces. The same views are applicable for the explanation of the aneurisms of the iliac region and lower extremity now to be described. As to the greater frequency of aneurism at particular localities than elsewhere, it seems to me that there exists no other assignable reason for the fact than that the nearer the artery is to the heart as the prime and sole mover of the arterial circulation, the greater is the momentum of the motionary blood (for it is true that in this particular the vital current is subservient to the physical law), and that hence the coats of the artery are subjected to the greater degree of distending force. This condition being unchangeable while no *rationale* can be advanced in regard to the question why a pathological degeneration of the coats of an artery should occur at one place rather than at another, the premises lead to the conclusion that as disease has no settled election for any one particular vessel more than for another, so the nearer the affected vessel is to the heart's force, the sooner, and consequently the more frequently, will it become the subject of aneurism, whose shape is the substantive type of distension. Conformably with this doctrine, we find that aneurisms of the aorta and primary branches are of more frequent occurrence than in respect to any of the other branches of the arterial system. But while we are recognising the operation of the law, that precisely in the ratio of the square of the distance from the heart is the circulating force of this organ expended, and expecting, therefore, that the farther the vessel is removed from the heart the less liable to aneurismal swelling it should be, certain pathological facts, as recorded, seem to be at variance with that doctrine. It is true, however, that the arteries of the leg and foot, the forearm and the hand, are less subject to aneurism than any of the other arteries, and this answers directly to the expectation; but not so with regard to arteries intermediate between the thorax and the lower segments of the limbs. Next in frequency to aneurism of the aorta and its primary branches, it is stated, upon extensive experience, that aneurism of the popliteal artery occurs; next to this vessel, the femoral; next to the femoral, the carotid; next to this, the subclavian; next, the axillary; next, the external iliac; then the innominate: and of the brachial, the common iliac, the anterior tibial, the internal iliac, temporal, ulnar, perinæal, internal carotid, radial, and palmar and plantar arteries, their liability to the disease is less and less common, according to the order in which they are now mentioned. This seeming irregularity as to the more frequent seat of aneurism attaching to arteries between their aortic common origin and their terminal distribution not being possible to be accounted for according to the known law of the circulating force above mentioned, has led the pathologist to seek for a cause of it in the structure of particular arteries, and the popliteal, more especially, has undergone an attentive examination. Accordingly, the artery most subject to the disease has presented itself, under the microscope, in the opinion of some, as having a coat of peculiar structure ("*sclerous*"), which is "dense, hard, fragile, and scaly, and is the seat of calcareous, or steatomatous, or cartilaginous deposits, which facilitate the formation of aneurism." But as this coat, as stated by other observers (and with good reason), does not, in reality, exist, they account for popliteal aneurism in either the violent extension or flexion of the leg fraying the coats of the vessel, and thus originating the disease. Of these two causes, however, the one would appear no less inappreciable than the other. If the sclerous coat of the artery most liable to aneurism is the cause of that disease in it, that coat (supposing it to exist anywhere) might be expected, like the other coats of the arteries, to exist everywhere, and all arteries be consequently equally prone to the disease: and if the motion of flexion or extension, even to the result of dislocation of the joint, does not cause the disease, why should a less violent motion be a cause of it? or more frequently one in respect to the popliteal space than at the bend of the elbow? Thus the problem, defying a plausible solution under either mode of computation, the facts, as effects, are to be handled as best they may, irrespective of their causes, when these cannot be understood. And, fortunately, in the case of an aneurism, wherever situated, or in whichever place it more frequently appears, the knowledge of such a cause has not a direct bearing on the principle according to which the surgical treatment of the disease is to be successfully conducted.

In the operative treatment, by deligation, of an aneurism, wherever situated, a condition of the affected artery presents itself which may be said in all cases to require the conduct of that measure to be different from that which serves well enough for exposing the vessel in the body, in which no aneurism exists. The tumour more or less displaces the vessel from which it arises, and, having the same effect with regard to contiguous parts, renders our knowledge of normal relative anatomy of less account than might be expected. This disadvantage, however, which would be in full force were it necessary to place the ligature on the artery at the seat of the disease, is not only not incurred by tying the vessel at some distance above the aneurism, but the operation here performed has the advantage of the ligature being removed from the diseased part. In order to insure this advantage, however, there are other considerations not to be lost sight of: if the case will admit of it, the ligature should be placed below the origins of the collateral branches, so as to give course to as full an amount as possible of the anastomotic circulation, upon which the maintenance of the vitality of the limb alone depends after the direct current has been arrested; and besides

FIGURES OF PLATE LII.

Figure 1.—The common iliac arteries, D C, are aneurismal, the right vessel being more dilated than the left. The aorta, A, at its bifurcation, is distorted towards B, the vena cava. Each of the two aneurisms compresses the common iliac vein, E, on which it rests. —F, External iliac artery.—G, Internal iliac artery.—H, First sacral vertebra.

Figure 2.—An aneurism, E E, is formed on the external iliac artery, B, above the origins of the epigastric and circumflex iliac branches; and, projecting inwards over the margin of the true pelvis, compresses the external iliac vein, C, behind it. Between the upper side of the aneurism and the bifurcation of the common iliac artery, A, into the branches, B D, a ligature has been placed.—F, Anterior superior iliac spinous process.—G, Symphysis pubis.—H, Femoral vein.—I, Femoral artery.

Figure 3.—The common femoral artery is dilated into an aneurism, C, of globular form. Close above Poupart's ligament, the external iliac artery, A, begins to swell where the epigastric and circumflex iliac branches arise from it in front, and where the external iliac vein passes under the tumour. From the outer side of the aneurism, the profunda femoris artery arises; from its lower side the femoral artery passes of its usual calibre; behind it is the femoral vein, G, under compression; and drooping close to its inner side appears the spermatic cord, having the same relation to the aneurism as it assumes in respect to a femoral hernia.—D, Symphysis pubis.—E, Iliac spinous process.—F, Testicle. —I, Sartorius muscle, partially overlapping the tumour.

Figure 4.—An aneurism, E F, springs from the femoral artery, F F, and occupies a situation between that vessel and the thigh-bone in Scarpa's triangle. The aneurism is renal-shaped, and has the upper part of the femoral artery passing into, and the lower part of that vessel passing from, its inner side, which distorts inwards the femoral vein, C G. The profunda artery, D, turns down behind the tumour; the sartorius, J J, lies obliquely in front of it; and the femoral artery is distorted and abruptly separated by it from the femur at the situation where the vessel approaches the inner side of that bone. —A, External iliac vein.—B, External iliac artery.—H, Anterior iliac spinous process.—I, Testicle.

Figure 5.—The popliteal artery is aneurismal. The tumour, I, is pyriform, dilating gradually downwards from the opening for the femoral vessel in the adductor magnus tendon, C. The popliteal vein, J, appearing on the outer side of the upper part of the tumour, passes before it lower down, and is under compression. The great sciatic nerve, N, and its branches, P O, are stretched over the back of the aneurism, while this is embraced on either side by the heads of the gastrocnemius muscle. In this case the femoral artery, E, is represented as double F G, and having the two divisions of the vessel united again, E, where it is about to pass through the opening in the adductor magnus tendon. The point at which the femoral artery divides is immediately below the origin of the profundus branch. The two divisions of the artery are of equal calibre; a ligature is placed on the middle of the inner one. The femoral vein, H, passes down on the inner side of the inner division of the artery.—A, Articular head of the right femur. —B, Tendon of gluteus maximus muscle.—D, Femoral head of biceps muscle.—K, Popliteal artery dividing into crural branches.—L, Fibula.—M, Tibia.

Figure 6.—The popliteal artery, B, is uniformly dilated into an aneurism, D, of so large proportions, that it completely fills the popliteal space. The vein, A, appearing external to the upper part of the tumour, passes in front of it below, and is compressed between it and the bone. The heads of the gastrocnemius, G G, embrace the tumour on either side; and the branches of the sciatic nerve, C C*, are stretched over its posterior outer surface. The vertical diameter of the aneurism extends from a point, B, close below the opening in the adductor tendon, H, to one a little above the division, B*, of the artery into the crural branches; its transverse diameter equals that of the condyloid end of the femur. The aneurism, D, became ruptured during life at its posterior surface, d. —E, Long head of the biceps muscle cut.—F, Femur.—I, Head of fibula.—J, Popliteus muscle.—K, Tendon of semimembranosus muscle cut, and turned down with L M, the tendons of the gracilis and sartorius muscles.

Figure 7.—Two aneurisms appear formed of the popliteal artery, C C*, which vessel, where it connects the two, is of its normal size. The upper tumour, D, is the smaller, and is situated behind the triangular flat surface of the femur above the condyles, F H, of that bone. The lower tumour, D*, is intercondyloid, and reaches down so far as partially to cover the popliteus muscle, where the popliteal artery appears for about an inch of its length before it divides into the crural branches. The nerves were stretched over the back of the aneurism, as usual; the popliteal vein, B, which has been pushed to the outer side of the upper aneurism, bends over the posterior outer surface, B*, of the lower one.—A, Femur.—E, Tendon of adductor muscle.—G, Tendon of semimembranosus muscle cut and turned down.—I, Head of fibula.

this we have to choose, as a site for the operation, that place whereat the vessel may be more readily exposed without, at the same time, involving other important organs. In tying the artery below the upper anastomotic branches, we leave the recurrent branches as well fully effective, whereas, in tying the vessel above both sets of branches, we cut off the circulation both collateral and direct; and this is a result which at once must determine the proper situation of the ligature, even with those who would insist that its close proximity to the distal side of a collateral branch is a cause of its "disturbance." But as this cause is by no means proven, while other more obvious causes may be recognised, the certain result, not the uncertain, must influence the operator.

Aneurism of the common iliac artery (Fig. 1) may be regarded, by reason of its situation, as not less ungovernable than aneurism of the abdominal aorta. The size of the common iliac, its almost inaccessible situation, and its close relationship with important organs, justify this conclusion in regard to either of the vessels; but of the two, the right one, as resting on the origin of the vena cava, and on the ends of the common iliac veins, is the more complicated. The aneurismal swelling, even in an early stage, involves the whole length of the artery, and in the future stages of its increase it subjects to more and more pressure the large veins in connexion with it. The peritonæum invests the whole tumour, whatever be its size, and that membrane has to be peeled from the iliac fossa and from the surface of the aneurism, in order to reach it in an operation with the object (if this be a reasonable requirement) of not opening the peritonæal sac; but this casualty is of comparatively small account in presence of other dangers which are inevitable. The whole length of the common iliac being from the first included in the aneurism, there is no room for the application of a ligature to it above the disease, and consequently, in order to arrest the circulation through it, it becomes necessary to tie the lower end of the abdominal aorta, whereby the circulation would be arrested in respect to the other common iliac artery also, and thus the lower limbs and the pelvis, and its organs (except the rectum, supplied by the inferior mesenteric), will be deprived of nearly all sources of support.

Aneurism of the external iliac artery (Fig. 2) renders the operation of deligation more or less serious, and promising a lesser or greater probability of a successful result, according to the stage of its development, and also the situation at which it arises from the vessel. If the aneurism be as yet small, and close to Poupart's ligament, the ligature can be safely applied to the vessel at its mid-point, or between this and its origin. Even when the aneurism (if small) attaches to the middle of the artery, it will admit of the application of a ligature to the upper end of the vessel; but if the aneurism spring from the upper third of the vessel, it will then be required to tie the common iliac. If the aneurism project from the outer side of, or from the forepart of the vessel, it will be more difficult to reach this at the point where it should be tied; but when the aneurism projects from the inner side of the artery towards the median line, the vessel will be found but little distorted from its normal situation, and it may be almost as readily exposed as if it were in a state of health. When the aneurism is in the situation last mentioned, the external iliac vein will be invariably found behind it; if it be near Poupart's ligament, the epigastric and circumflex iliac branches will arise from it; and if it be near the bifurcation of the common iliac, the ureter will cross inwards over it, while, perhaps, also, the internal iliac will be found to be involved in the upper part of its periphery, thus necessitating that the operation should be conducted in reference to the common iliac.

Aneurism of the common femoral artery (Fig. 3), even though small, involves the whole of this part of the main artery. This aneurism is peculiarly circumstanced in regard to its investments: it is crossed by Poupart's ligament, and the part of it above this structure is covered by the peritonæum, while below the ligament the sheath of the vessels forms a covering for it, and, also, it is bound down by the fascia lata. When the epigastric and circumflex iliac branches have their origin from the usual part of the external iliac, that is, close above Poupart's ligament, they will be found arising from the upper part of the tumour; and, in almost all instances, the profunda artery will have its origin from the outer side of the tumour below the ligament. This aneurism occupies the situation of a femoral hernia when the fascia, repressing it externally, gives it the direction of the saphenous opening. Then the spermatic cord will hang close along its inner side; the adductor muscles will be behind it; the sartorius on its outer side, and Poupart's ligament above it: but the common femoral vein has a different relation to the aneurism and to the hernia; in the former case, the vein will be either on the inner side of, or behind, the tumour, whereas, in the latter, the vein is invariably on its outer side. Whatever be the size of the common femoral aneurism, it necessitates the application of a ligature to the external iliac.

Aneurism of the femoral artery (Fig. 4), if happening low down in the thigh, will admit of the application of a ligature to the vessel from which it springs, with less sacrifice of the collateral branches than if it be situated close below the profundus branch; for in the former case there will be a healthy interval of the vessel between the disease and the profundus, where the ligature may be placed; whereas, in the latter case, it will be necessary to tie the common femoral, at the sacrifice of the profundus branch, as also of the epigastric and circumflex iliac, should these arise (as they frequently do) from that branch, or from the common femoral close to its origin. At whichever part of the femoral artery the aneurism is developed, the vein will be found close to its inner side or behind it, and many of the branches of the anterior crural nerve crossing down over it.

Aneurism of the popliteal artery (Figs. 5, 6, 7) generally, in its final stages of increase, involves the whole length of this portion of the vessel, and therefore requires that the operation of deligation should be conducted in reference to the artery in the forepart of the thigh. This necessity, indeed, is occasioned even though the aneurism be in its primary stages, because of the difficulty of reaching the vessel in the popliteal space above the aneurism, and the probability of finding it, when exposed, in an unsound state here. Added to these considerations, the fact of the artery being more readily accessible in the thigh, where the ligature can be applied at a distance from the disease, with the same effect, in regard to command over the circulation of the tumour, and with greater advantage in respect to the preservation of the collateral circulation, make altogether a sum of persuasive evidence in favour of performing the operation in the forepart of the thigh. Of this aneurism (more especially, perhaps, than of others) the relative position requires particularly to be studied, in order to explain the effects occasioned by pressure on neighbouring parts—the veins and nerves,—and also to aid in its diagnosis. Before it attains to any considerable size it does not occasion a tumour of very obvious character, as explanatory of its nature, for the adipose tissue surrounding it is readily displaced or becomes absorbed, and the flexor muscles standing apart from either side of it, and projecting to a plane posterior to that of it, mask its presence. The tumour in this situation may arise from other causes than that of aneurism; such as an abscess originating in one of the popliteal lymphatic bodies, or an accumulation of the fluid in one or other of the bursæ, in both of which cases the sac lying in contact with the artery will have a more or less marked pulsation communicated to it from that vessel. The relative position which the great sciatic nerve and its branches has in respect to the artery in its normal condition is not changed in regard to the aneurism—the posterior tibial nerve descends perpendicularly behind it, and is that which, from the increasing size of the tumour, is liable to be stretched and compressed, causing a numbness in the leg and foot; while the peronæal nerve, passing down over its outer side, is not so subjected to the same force. The popliteal vein occasionally assumes a different relative position to the aneurism from that which it holds in respect to the artery undiseased: the vein in some instances is superficial to the aneurism, and forced into apposition with the posterior tibial nerve; but generally it is deep on the outer side of the aneurism, and frequently between this and the bone, in which position especially it undergoes compression, and gives rise to œdema of the leg and foot. When a rupture of the aneurism happens, the opening more frequently occurs at its posterior surface than elsewhere, for that is the side which most admits of distension and a thinning of its walls; in front the bone represses its distension, and the flexor muscles act in the same way at its sides. A single aneurism of the artery is what happens for the most part in the popliteal space; but occasionally two aneurisms exist, and of these the lower one is always the larger, for, as noticed in a former place, it is the lower which is first formed, and having attained to large proportions and deposited a coagulum, it induces the formation of the upper one by the obstruction which it occasions to the circulation of the vessel, which is likewise the reason why an aneurism occurring second in time to the first can never be *below* the one first formed. When the aneurism is so large as to occupy completely the popliteal space distended beyond its natural capacity, it involves the origins of the five articular branches; and when the femoral vessel has been tied for the disease, the direct circulation is still further arrested in consequence of the ligature being above the anastomotic branch. The collateral currents can then only be maintained through the muscular branches, and these are they which, in a *post-mortem* examination of the limb of patients who have survived the operation, are found to be enlarged.

CONCLUDING COMMENTARY.

THE FORM AND DISTRIBUTION OF THE VASCULAR SYSTEM AS A WHOLE.—ANOMALIES.—RAMIFICATION.—ANASTOMOSIS.—SIGNIFICATION OF THE PORTAL SYSTEM, THE LIVER, AND THE SPLEEN.

I.—The heart, in all stages of its development, is to the vascular system what the point of a circle is to the circumference—namely, at once *the beginning and the end.* The heart, occupying, it may be said, the centre of the thorax, circulates the blood in the same way, by similar channels, to an equal extent, in equal pace, and at the same period of time, through both sides of the body. In its adult normal condition, the heart presents itself as a double or symmetrical organ. The two hearts, though united and appearing single, are nevertheless, as to their respective cavities, absolutely distinct. Each heart consists again of two compartments—an auricle and a ventricle. The two auricles are similar in structure and form. The two ventricles are similar in the same respects. A septum divides the two auricles, and another—the two ventricles. Between the right auricle and ventricle, forming the right heart, there exists a valvular apparatus (tricuspid), by which these two compartments communicate; and a similar valve (bicuspid) admits of communication between the left auricle and ventricle. The two hearts being distinct, and the main vessels arising from them respectively being distinct likewise, it follows that the capillary peripheries of these vessels form the only channels through which the blood issuing from one heart can enter the other.

II.—As the aorta of the left heart ramifies throughout all parts of the body, and as the countless ramifications of this vessel terminate in an equal number of ramifications of the principal veins of the right heart, it will appear that between the systemic vessels of the two hearts respectively, the capillary anastomotic circulation reigns *universal.*

III.—The body generally is marked by the median line from the vertex to the perinæum, into corresponding halves. All parts excepting the main bloodvessels in the neighbourhood of the heart are naturally divisible by this line into equals. The vessels of each heart, in being distributed to both sides of the body alike, cross each other at the median line, and hence they are inseparable according to this line, unless by section. If the vessels proper to each heart, right and left, ramified alone within the limits of their respective sides of the body, then their capillary anastomosis could only take place along the median line, and here in such case they might be separated by median section into two distinct systems. But as each system is itself double in branching into both sides of the body, the two would be at the same time equally divided by vertical section. From this it will appear that the vessels belonging to *each* heart form a symmetrical system, corresponding to the sides of the body, and that the capillary anastomosis of these systemic veins and arteries is divisible into *two great fields*, one situated on either side of the median line, and touching at this line.

IV.—The vessels of the right heart do not communicate at their capillary peripheries, for its veins are systemic, and its arteries are pulmonary. The vessels of the left heart do not anastomose, for its veins are pulmonary, and its arteries are systemic. The arteries of the right and left hearts cannot anastomose, for the former are pulmonary and the latter are systemic; and neither can the veins of the right and left hearts, for a similar reason. Hence, therefore, there can be, between the vessels of both hearts, but *two provinces of anastomosis*—viz., that of the lungs and that of the system. In the lungs, the arteries of the right heart and the veins of the left anastomose. In the body generally (not excepting the lungs), the arteries of the left heart, and the veins of the right, anastomose; and thus in the pulmonary and systemic circulation, each heart plays an equal part through the medium of its proper vessels. The pulmonary vessels bear to the systemic the same relation as a lesser circle contained within a greater; and the vessels of each heart form the half of each circle, the arteries of the one being opposite the veins of the other.

V.—The two hearts being, by the union of their similar forms, as one organ in regard to place, act, by an agreement of their corresponding functions, as one organ in respect to time. The action of the auricles is synchronous; that of the ventricles is the same; that of the auricles and ventricles is consentaneous; and that of the whole heart is rhythmical, or harmonious—the diastole of the auricles occurring in harmonical time with the systole of the ventricles, and *vice versâ.* By this correlative action of both hearts, the pulmonary and systemic circulations take place synchronously; and the phenomena resulting in both reciprocate and balance each other. In the pulmonary circulation, the blood is aerated, decarbonized, and otherwise depurated; whilst in the systemic circulation, it is carbonized and otherwise deteriorated.

VI.—The circulation through the lungs and the system is carried on through vessels having the following form and relative position, which, as being most usual, is accounted normal. The two brachio-cephalic veins joining at the root of the neck, and the two common iliac veins joining in front of the lumbar vertebræ, form the superior and inferior venæ cavæ, by which the blood is returned from the upper and lower parts of the body to the right auricle, and thence it enters the right ventricle, by which it is impelled through the pulmonary artery into the two lungs; and from these it is returned (aerated) by the pulmonary veins to the left auricle, which passes it into the left ventricle, and by this it is impelled through the systemic aorta, which branches throughout the body in a similar way to the systemic veins, with which the aortic branches anastomose generally. On viewing together the system of vessels proper to each heart, they will be seen to exhibit in respect to the body a figure in doubly symmetrical arrangement, of which the united hearts form a duplex centre. At this centre, which is the theatre of metamorphosis, the principal abnormal conditions of the bloodvessels appear; and in order to find the signification of these, we must retrace the stages of development.

VII.—From the first appearance of an individualized centre in the vascular area of the human embryo, that centre (punctum saliens) and the vessels immediately connected with it, undergo a phaseal metamorphosis, till such time after birth as they assume their permanent character. In each stage of metamorphosis, the embryo heart and vessels typify the normal condition of the organ in one of the lower classes of animals. The several species of the organ in these classes are parallel to the various stages of change in the human organ. In its earliest condition, the human heart presents the form of a simple canal, similar to that of the lower Invertebrata, the veins being connected with its posterior end, while from its anterior end a single artery emanates The canal next assumes a bent shape, and the vessels of both its ends become thereby approximated. The canal now being folded upon itself in heart-shape, next becomes constricted in situations, marking out the future auricle and ventricle and arterial bulb, which still communicate with each other. From the artery are given off on either side symmetrically five branches (branchial arches), which arch laterally from before, outwards and backwards, and unite in front of the vertebræ, forming the future descending aorta. In this condition, the human heart and vessels resemble the Piscean type. The next changes which take place consist in the gradual subdivision, by means of septa, of the auricle and ventricle respectively into two cavities. On the separation of the single auricle into two, while the ventricle as yet remains single, the heart presents that condition which is proper to the Reptilian class. The interauricular and interventricular septa, by gradual development from without inwards, at length meet and coalesce, thereby dividing the two cavities into four—two auricles and two ventricles—a condition proper to the Avian and Mammalian classes generally. In the centre of the interauricular septum of the human heart, an aperture (*foramen ovale*) is left as being necessary to the fœtal circulation. While the septa are being completed, the arterial bulb also becomes divided by a partition formed in its interior in such a manner as to adjust the two resulting arteries, the one in connexion with the right, the other with the left ventricle. The right ventricular artery (pulmonary aorta) so formed, has assigned to it the fifth (posterior) opposite pair of arches, and of these the right one remaining pervious to the point where it gives off the right pulmonary branch, becomes obliterated beyond this point to that where it joins the descending aorta, while the left arch remains pervious during fœtal life, as the *ductus arteriosus* still communicating with the descending aorta, and giving off at its middle the left pulmonary branch. The left ventricular artery (systemic aorta) is formed of the fourth arch of the left side, while the opposite arch (fourth right) is altogether obliterated. The third and second arches remain pervious on both sides, afterwards to become the right and left brachio-cephalic arteries. The first pair of arches, if not converted into the vertebral arteries, or the thyroid axes, are altogether metamorphosed. By these changes the heart and primary

arteries assume the character in which they usually present themselves at birth, and in all probability the primary veins corresponded in form, number, and distribution with the arterial vessels, and underwent, at the same time, a similar mode of metamorphosis. One point in respect to the original symmetrical character of the primary veins is demonstrable—namely, that in front of the aortic branches the right and left brachio-cephalic veins, after joining by a cross branch, descend separately on either side of the heart, and enter (as two superior venæ cavæ) the right auricle by distinct orifices. In some of the lower animals, this double condition of the superior veins is constant, but in the human species the left vein below the cross branch (left brachio-cephalic) becomes obliterated, whilst the right vein (vena cava superior) receives the two brachio-cephalic veins, and in this condition remains throughout life. After birth, on the commencement of respiration, the *foramen ovale* of the interauricular septum closes, and the *ductus arteriosus* becomes impervious. This completes the stages of metamorphosis, and changes the course of the simple fœtal circulation to one of a more complex order—viz., the systemic-pulmonary characteristic of the normal state in the adult body.

VIII.—Such being the phases of metamorphosis of the primary (branchial) arches which yield the vessels in their normal adult condition, we obtain in this history an explanation of the signification not only of such of their anomalies as are on record, but of such also as are *potential* in the law of development; a few of them will suffice to illustrate the meaning of the whole number:—1*st.* The interventricular as well as the interauricular septum may be arrested in growth, leaving an aperture in the centre of each; the latter condition is *natural to the human fœtus*, the former *to the reptilian class*, while both would be *abnormal in the human adult.* 2*nd.* The heart may be *cleft at its apex* in the situation of the interventricular septum—a condition *natural to the Dugong.* A similar cleavage may divide the *base of the heart* in the situation of the interauricular septum. 3*rd.* The *partitioning of the bulbus arteriosus* may occur in such a manner as to assign to the two aortæ a relative position, the *reverse* of that which they *normally* occupy —the *pulmonary aorta* springing from the *left ventricle* and the *systemic aorta* arising from the *right*, and giving off from its arch the *primary branches* in the usual order.* 4*th.* As the *two aortæ* result from a *division* of the *common primary vessel* (*bulbus arteriosus*), an *arrest* in the growth of the partition would leave them still as *one vessel*, which (supposing the ventricular septum remained also incomplete) would then arise from a *single ventricle.* 5*th.* The *ductus arteriosus* may remain *pervious*, and while co-existing with the proper *aortic arch*, *two arches* would then appear on the *left side.* 6*th.* The *systemic normal aortic arch* may be obliterated as far up as the *innominate branch*, and while the *ductus arteriosus* remains *pervious*, and leading from the pulmonary artery to the descending part of the aortic arch, this vessel would then present the appearance of *a branch* ascending from the left side and giving off the brachio-cephalic arteries. The *right ventricular artery* would then, through the medium of the *ductus arteriosus*, supply both the lungs and the system. Such a state of the vessels would require (in order that the circulation of a mixed blood might be carried on) that the two ventricles freely communicate. 7*th.* If the *fourth arch* of the *right side* remained pervious opposite the *proper aortic arch*, there would exist *two aortic arches* placed *symmetrically*, one on either side of the vertebral column, and, joining below, would *include in the circle* the trachea and œsophagus. 8*th.* If the *fifth arch* of the *right side* remained *pervious* opposite the *open ductus arteriosus*, both vessels would present a similar arrangement, as *two symmetrical ducti arteriosi* co-existing with symmetrical aortic arches. 9*th.* If the vessels appeared *co-existing* in the *two conditions* last mentioned, they would represent *four aortic arches, two on either side of the vertebral column.* 10*th.* If the *fourth right arch, instead of the fourth left* (aorta), remained *pervious*, the *systemic aortic arch* would then be turned to the *right side* of the vertebral column, and have the trachea and œsophagus on its *left.* 11*th.* When the *bulbus arteriosus* divides itself into *three parts*, the *two lateral parts*, in becoming connected with the *left ventricle*, will represent a *double ascending systemic aorta*, and having the *pulmonary artery* passing *between them* to the lungs. 12*th.* When of the *two original superior venæ cavæ* the *right one* instead of the left suffers metamorphosis, the *vena cava superior* will then appear on the *left side* of the *normal aortic arch.*† Of these malformations, some are rather frequently met with, others very seldom, and others cannot exist compatible with life after birth. Those which involve a more or less imperfect discharge of the blood-aerating functions of the lungs are in those degrees more or less fatal, and thus nature aborting as to the fitness of her creation, cancels it. Passing from the consideration of those anomalies appearing in the vascular centre to that of the anomalies of the systemic arteries, we shall find that these may be gathered together under the following explicative generalization: their deviations from the normal (usual) type are simply in regard to length, and these simply are the result either of an unusually high or low position at which the main artery subdivides; this, though we write volumes upon the theme, is all the information derivable from their comparison to satisfy inquiry, whether our object be theoretical or practical.

IX.—The *portal system of veins* passing *to* the liver, and the hepatic veins passing *from* this organ to join the inferior vena cava, exhibit in respect to the median line of the body an example of a-symmetry, since appearing on the right side, they have no counterparts on the left. As the law of symmetry seems to prevail universally in the development of organized beings, forasmuch as every lateral organ or part has its counterpart, while every central organ is double or complete in having two similar sides, then the portal system, as being an exception to this law, is as a natural note of interrogation questioning the signification of that fact, and in the following observations, it appears to me, the answer may be found. Every artery in the body has its companion vein or veins. The inferior vena cava passes sidelong with the aorta in the abdomen. Every branch of the aorta which ramifies upon the abdominal parietes has its accompanying vein returning either to the vena cava or the vena azygos, and entering either of these vessels at a point on the same level as that at which itself (the artery) arises. The renal vessels also have this arrangement. But all the other veins of the abdominal viscera, instead of entering the vena cava opposite their corresponding arteries, unite into a single trunk (vena portæ), which enters the liver. The special purpose of this destination of the portal system is obvious, but the function of a part gives no explanation of its form or relative position, whether singular or otherwise. On viewing the vessels in presence of the general law of symmetrical development, it occurs to me that the *portal* and *hepatic veins form one continuous system*, which taken in *the totality*, represents the *companion veins of the arteries of the abdominal viscera.* The liver under this interpretation appears as a gland *developed midway* upon these veins, *dismembering them* into a mesh of countless capillary vessels, (a condition necessary for all processes of secretion,) for the special purpose of decarbonizing the blood. In this great function the liver is an organ correlative or compensative to the lungs, whose office is similar. The secretion of the liver (bile) is fluidform; that of the lungs is aeriform. The bile being necessary to the digestive process, the liver has a duct to convey that product of its secretion to the intestines. The trachea is, as it were, the duct of the lungs. In the liver, then, *the portal* and *hepatic veins* being continuous *as veins*, the two systems, notwithstanding their apparent distinctness caused by the intervention of the hepatic lobules, may be regarded as the *veins corresponding with the arteries of the cœliac axis, and the two mesenteric.* The hepatic artery and the hepatic veins evidently do *not* pair in the sense of *afferent* and *efferent*, with respect to the liver, both these vessels having destinations as different as those of the bronchial arteries and the pulmonary veins in the lungs. The bronchial artery is attended by its vein proper, while the vein which corresponds to the hepatic artery joins either the hepatic or portal veins traversing the liver, and in this position escapes notice.

X.—*The heart*, though being itself the recipient, the prime mover, and the dispenser of the blood, does not depend either for its growth, vitality, or stimulus to action, upon the blood under these uses, but upon the blood circulating through vessels which are derived from its main systemic artery, and disposed in capillary ramifications through its substance, in the manner of the nutrient vessels of all other organs. The two *coronary arteries* of the heart arise from the systemic aorta immediately outside the semilunar valves, situated in the root of this vessel, and in passing right and left along the auriculo-ventricular furrows, they send off some branches for the supply of the organ itself, and others by which both vessels anastomose freely around its base and apex. The *vasa cordis* form an anastomotic circulation altogether isolated from the vessels of the other thoracic organs, and also from

* This physiological truth has, I find, been applied by Dr. R. Quain to the explanation of a numerous class of malformations connected with the origins of the great vessels from the heart, and of their primary branches. See *The Lancet*, vol. i. 1842.

† For an analysis of the occasional peculiarities of these primary veins in the human subject, see an able and original monograph in the *Philosophical Transactions*, Part I., 1850, entitled, "On the Development of the Great Anterior Veins in Man and Mammalia." By John Marshall, F.R.C.S., &c.

those distributed to the thoracic parietes. The coronary arteries are accompanied by veins which open by distinct orifices (*foramina Thebesii*) into the right auricle. Like the heart itself, its main vessels do not depend for their support upon the blood conveyed by them, but upon that circulated by the small arteries (*vasa vasorum*) derived either from the vessel upon which they are distributed, or from some others in the neighbourhood. These little arteries are attended by veins of a corresponding size (*venules*) which enter the venæ comites, thus carrying out the general order of vascular distribution to the minutest particular. Besides the larger nerves which accompany the main vessels, there are delicate filaments of the cerebro-spinal and sympathetic system distributed to their coats, for the purpose, as it is supposed, of governing their "contractile movements." The *vasa vasorum* form an anastomosis as well upon the inner surface of the sheath as upon the artery contained in this part; and hence in the operation for tying the vessel, the rule should be to disturb its connexions as little as possible, otherwise its vitality, which depends upon these minute branches, will, by their rupture, *be destroyed in the situation of the ligature, where it is most needed.*

XI.—*The branches of the systemic aorta* form frequent anastomoses with each other in all parts of the body. *This anastomosis occurs chiefly amongst the branches of the main arteries proper to either side.* Those branches of the opposite vessels which join at the median line are generally of very small size. There are but few instances in which a large bloodvessel *crosses the central line from its own side to the other.* Anastomosis at the median line between opposite vessels happens either by a *fusion of their sides* lying parallel, as, for example (and the only one), that of the two vertebral arteries on the basilar process of the occipital bone; or else by a direct *end-to-end union*, of which the lateral pair of cerebral arteries, forming the *circle of Willis*, and the two labial arteries forming the coronary, are examples. The branches of the main arteries of one side form numerous anastomoses in the muscles and in the cellular and adipose tissue generally. Other special branches derived from the parent vessel above and below the several joints ramify and anastomose so very freely over the surfaces of these parts, and seem to pass in reference to them out of their direct course, that to effect this mode of distribution appears to be no less immediate a design than to support the structures of which the joints are composed.

XII.—*The innominate artery.* When this vessel is tied, the free direct circulation through the principal arteries of the right arm, and the right side of the neck, head, and brain, becomes arrested; and the degree of strength of the recurrent circulation depends solely upon the amount of anastomosing points between the following arteries of the opposite sides:—The small terminal branches of the two occipital, the two auricular, the two superficial temporal, and the two frontal, inosculate with each other upon the sides, and over the vertex of the head,—the two vertebral, and the branches of the internal carotid, inosculate at the base and over the surface of the brain,—the two facial inosculate with each other, and with the frontal above and the mental below, at the median line of the face,—the two internal maxillary inosculate by their palatine, pharyngeal, meningeal, and various other branches upon the surface of the parts to which they are distributed,—and lastly, the two superior thyroid arteries inosculate around the larynx and in the thyroid body. By these anastomoses it will be seen that the circulation is restored to the branches of the common carotid almost solely. In regard to the subclavian artery, the collateral circulation would be carried on through the anastomosing branches of the two inferior thyroid in the thyroid body,—through those of the two vertebral, in the cranium and upon the cervical vertebræ,—through those of the two internal mammary, with each other behind the sternum, and with the thoracic branches of the axillary and the superior intercostal laterally,—lastly, through the anastomosing branches of the ascending cervical and the descending occipital, with each other, and with the small lateral offsets of the vertebral.

XIII.—*The common carotid arteries.* Of these two vessels, the left one, arising, in general, from the arch of the aorta, is longer than the right one by the measure of the innominate artery from which the right arises. When either of the common carotids is tied, the circulation will be maintained through the anastomosing branches of the opposite vessels as above specified. When the vertebral or the inferior thyroid branch arises from the middle of the common carotid, this vessel will have an additional source of supply if the ligature be applied to it below the origin of such branch. In the absence of the innominate artery, the right as well as the left carotid will be found to spring directly from the aortic arch.

XIV.—*The subclavian arteries.* When a ligature is applied to the inner third of this vessel within its primary branches, the collateral circulation is carried on by the anastomoses of the arteries above mentioned; but if the vertebral or the inferior thyroid arises either from the aorta or the common carotid, the sources of arterial supply in respect to the arm will, of course, be less numerous. When the outer portion of the subclavian is tied between the scalenus and the clavicle, while the branches arise from its inner part in their usual position and number, the collateral circulation in reference to the arm is maintained by the following anastomosing branches:—viz., those of the superficialis colli, and the supra and posterior scapular, with those of the acromial-thoracic, the subscapular, and the anterior and posterior circumflex around the shoulder-joint and over the dorsal surface of the scapula; and those of the internal mammary and superior intercostal, with those of the thoracic arteries arising from the axillary. Whatever be the variety as to their mode or place of origin, the branches emanating from the subclavian artery are constant as to their destination. The length of the inner portion of the right subclavian will vary according to the place at which it arises, whether from the innominate artery, from the ascending, or from the descending part of the aortic arch.

XV.—*The axillary artery.* As this vessel gives off throughout its whole length numerous branches which inosculate principally with the scapular, mammary, and superior intercostal branches of the subclavian, it will be evident that, in tying it above its own branches, the anastomotic circulation will, with much greater freedom, be maintained in respect to the arm, than if the ligature be applied below those branches. Hence, therefore, when the axillary artery is affected with aneurism, thereby rendering it unsafe to apply a ligature to this vessel, it becomes not only pathologically, but anatomically, the more prudent measure to tie the subclavian immediately above the clavicle.

XVI.—*The brachial artery.* When this artery is tied immediately below the axilla, the collateral circulation will be weakly maintained, in consequence of the small number of anastomosing branches arising from it above and below the seat of the ligature. The two circumflex humeri alone send down branches to inosculate with the small muscular offsets from the middle of the brachial artery. When tied in the middle of the arm, between the origins of the superior and inferior profunda arteries, the collateral circulation will depend chiefly upon the anastomosis of the former vessel with the recurrent branch of the radial, and of muscular branches with each other. When the ligature is applied to the lower third of the vessel, the collateral circulation will be comparatively free through the anastomoses of the two profundi branches with the radial, interosseous, and ulnar recurrent branches. If the artery happen to divide in the upper part of the arm into either of the branches of the forearm, or into all three, a ligature applied to any one of them will, of course, be insufficient to arrest the direct circulation through the forearm, if this be the object in view, as in a case of hæmorrhage. But in the case of aneurism, if the diseased abnormal branch be that to which the ligature is applied, not only will the desired result in respect to the aneurism be attained, but the existence of the other branches will be an advantage, forasmuch as through them the forearm and hand will still be supplied by the direct circulation, and not dependent solely upon the scarce collateral currents, which they must be when the brachial artery is single, as in the usual form, and a ligature applied to it arrests entirely the direct current in respect to the lower segments of the member.

XVII.—*The radial artery.* If this vessel be tied in any part of its course, the collateral circulation will depend principally upon the free communication between it and the ulnar, through the medium of the superficial and deep palmar arches and those of the branches derived from both vessels, and from the two interossei distributed to the fingers and back of the hand.

XVIII.—*The ulnar artery.* When this vessel is tied, the collateral circulation will depend upon the anastomosis of the palmar arches, as in the case last mentioned. While the radial, ulnar, and interosseous arteries spring from the same main vessel, and are continuous with each other in the hand, they represent the condition of a circle of which, when either side is tied, the blood will pass in a current of almost equal strength towards the seat of the ligature from above and below—a circumstance which renders it necessary to tie both ends of the vessel in cases of wounds.

XIX.—*The common iliac artery.* When a ligature is applied to the middle of this artery, the direct circulation becomes arrested in the lower limb and side of the pelvis corresponding to the vessel operated on. The collateral circulation will then be carried on by the anastomosis of the following branches:—viz., of those of the lumbar, the internal mammary, and the epigastric arteries of that side with each

other, and with their fellows in the anterior abdominal parietes,—of those of the middle and lateral sacral,—of those of the superior with the middle and inferior hæmorrhoidal,—of those of the aortic and internal iliac uterine branches in the female,—and of the aortic and external iliac spermatic branches in the male. The anastomoses of these arteries with their opposite fellows along the median line are much less frequent than those of the arteries of the neck and head.

XX.—*The external iliac artery.* This vessel, when tied at its middle, will have its collateral circulation carried on by the anastomoses of the internal mammary with the epigastric,—by those of the ilio-lumbar with the circumflex iliac,—by those of the internal circumflex femoris and superior perforating arteries of the profunda femoris, with the obturator, when this branch arises from the internal iliac,—by those of the gluteal with the external circumflex,—by those of the latter with the sciatic,—and by those of both obturators with each other, when arising, the one from the internal, the other from the external iliac. Not unfrequently either the epigastric, obturator, ilio-lumbar, or circumflex iliac, arises from the middle of the external iliac, in which case the ligature should be placed above such branch, rather than close below it, if the doctrine be true (which I myself believe it not to be), that the ligature in the latter position suffers disturbance by the circulation through the branch ere the process of closure in respect to the parent trunk is completed.

XXI.—*The common femoral artery.* On considering the circles of inosculation formed around the innominate bone between the branches derived from the iliac arteries near the sacro-iliac junction, and those emanating from the common femoral, above and below Poupart's ligament, it will at once appear that, in respect to the lower limb, the collateral circulation will occur more freely if the ligature be applied to the main vessel (external iliac) than if to the common femoral below its branches.

XXII.—*The superficial femoral artery.* When a ligature is applied to this vessel at the situation where it is overlapped by the sartorius muscle, the collateral circulation will be maintained by the following arteries:—the long descending branches of the external circumflex beneath the rectus muscle, inosculating with the muscular branches of the anastomotica magna springing from the lower third of the main vessel,—the three perforating branches of the profunda, inosculating with the latter vessel, with the sciatic, and with the articular and muscular branches around the knee-joint.

XXIII.—*The popliteal artery.* When any circumstance renders it necessary to tie this vessel in preference to the femoral, the ligature should be placed above its upper pair of articular branches; for by so doing a freer collateral circulation will take place in reference to the leg. The ligature in this situation will lie between the anastomotic and articular arteries, which freely communicate with each other.

XXIV.—*The anterior and posterior tibial and peronæal arteries.* As these vessels correspond to the arteries of the forearm, the observations which apply to the one set apply also to the other.*

* For a complete history of the general vascular system, see *The Anatomy of the Arteries of the Human Body,* by Richard Quain, F.R.S., &c., in which work, besides the results of the author's own great experience and original observations, will be found those of Haller's, Scarpa's, Tiedemann's, &c., systematically arranged with a view to operative surgery.

In instancing the facts noticed in the text, as serving under comparison to explain how the hepatic vessels constitute no *radical* exception to the law of symmetry which presides over the development and distribution of the vascular system as a whole, I am led to inquire in what respect (if in any) the liver as an organ forms an exception to this general law either in shape, in function, or in relative position. While seeing that every central organ is single and symmetrical by the union of two absolutely similar sides, and that each lateral pair of organs is double by the disunion of sides so similar to each other in all respects that the description of either side serves for the other opposite, it has long since seemed to me a reasonable inference that, since the liver on the right has no counterpart *as a liver* on the left, and that, since the spleen on the left has no counterpart *as a spleen* on the right, so these two organs (the liver and spleen) must themselves correspond to each other, and as such, express their respective significations. Under the belief that every exception (even though it be normal) to a general law or rule, is, like the anomaly itself, alone explicable according to such law, and expressing a fact not more singular or isolated from other parallel facts than is one form from another, or from all others constituting the graduated scale of being, I would, according to the light of this evidence alone, have no hesitation in stating that the liver and spleen, as opposites, represent corresponding organs, even though they appeared at first view more dissimilar than they really are. In support of this analogy of both organs, which is here, so far as I am aware, originally enunciated for anatomical science, I record the following observations:—1*st.* Between the opposite parts of the *same* organic entity (between the opposite leaves of the same plant, for example), nature manifests no such absolute difference in any case as exists between the leaf of a plant and of a book. 2*ndly.* When between two opposite parts of the *same* organic form there appears any differential character, this is simply the result of a modification or metamorphosis of one of the two perfectly similar originals or archetypes, but never carried out to such an extreme degree as to annihilate all trace of their analogy. 3*rdly.* The liver and the spleen are opposite parts; and as such, they are associated by arteries which arise by a single trunk (cœliac axis) from the aorta, and branch right and left, like indices pointing to the relationship between both these organs, in the same manner as the two emulgent arteries point to the opposite renal organs. 4*thly.* The liver is divided into two lobes, right and left; the left is less than the right; that quantity which is wanting to the left lobe is equal to the quantity of a spleen; and if in idea we add the spleen to the left lobe of the liver, both lobes of this organ become quantitatively equal, and the whole liver symmetrical; hence, as the liver *plus* the spleen represents the whole structural quantity, so the liver *minus* the spleen signifies that the two organs now dissevered still relate to each other as parts of the same whole. 5*thly.* The liver, as being *three-fourths* of the whole, possesses the *duct* which emanates at the centre of all glandular bodies. The spleen as being *one-fourth* of the whole, is *devoid* of the duct. The liver having the duct, is functional as a gland, while the spleen having no duct, cannot serve any such function. If, in thus indicating the function which the spleen does *not* possess, there appears no proof positive of the function which it *does,* perhaps the truth is, that as being the ductless portion of the whole original hepatic quantity, it exists as a thing degenerate and functionless, for it seems that the animal economy suffers no loss of function when deprived of it. 6*thly.* In early fœtal life, the left lobe of the liver *touches* the spleen on the left side; but in the process of abdominal development, the two organs become separated from each other right and left. 7*thly.* In animals devoid of the spleen, the liver appears of a *symmetrical* shape, both its lobes being *equal;* for that quantity which in other animals has become splenic, is in the former still hepatic. 8*thly.* In cases of transposition of both organs, it is the *right* lobe of the liver—that *nearest the spleen,* now on the right side—which is the *smaller* of the two lobes, proving that whichever lobe be in this condition, the *spleen,* as being opposite to it, *represents the minus hepatic quantity.* From these, among other facts, I infer that the spleen is the representative of the liver on the left side, and that as such, its signification being manifest, there exists no exception to the law of animal symmetry. "Tam miram uniformitatem in planetarum systemate, necessario fatendum est intelligentia et concilio fuisse effectam. Idemque dici possit de uniformitate illa quæ est in corporibus animalium. Habent videlicet animalia pleraque omnia, bina latera, dextrum et sinistrum, forma consimili: et in lateribus illis, a posteriore quidem corporis sui parte, pedes binos; ab anteriori autem parte, binos armos, vel pedes, vel alas, humeris affixos: interque humeros collum, in spinam excurrens, cui affixum est caput; in eoque capite binas aures, binos oculos, nasum, os et linguam; similiter posita omnia, in omnibus fere animalibus."—*Newton, Optices, sive de reflex., &c.* p. 411.

THE END.